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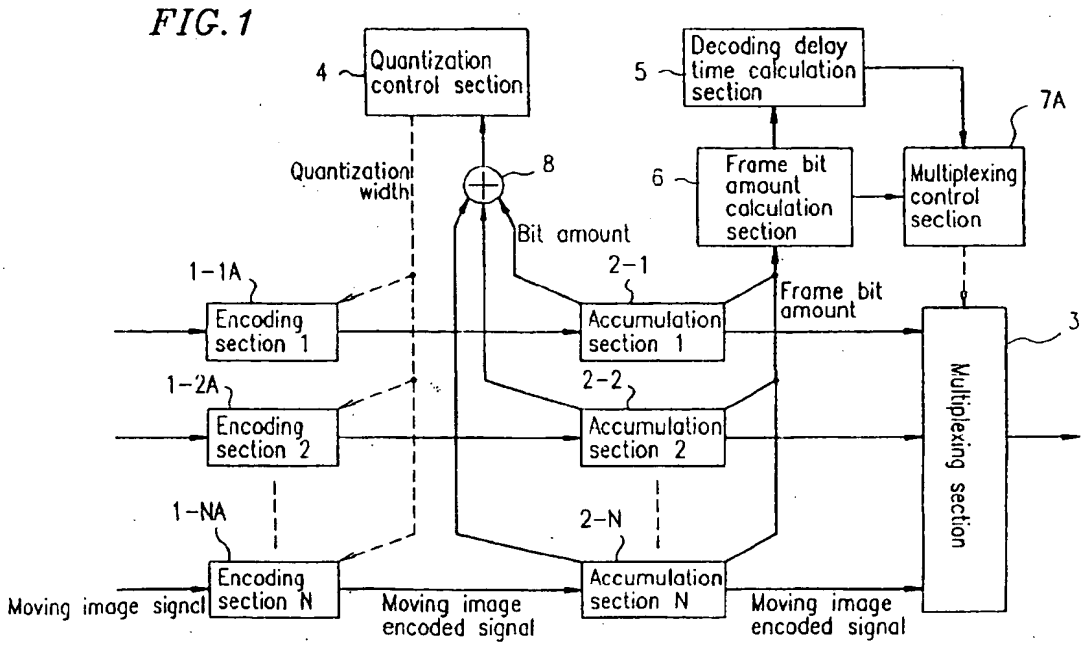
(54) Method and apparatus for encoding, multiplexing and transmitting a video signal

(57) The moving image encoding device for encoding a plurality of moving image signals of this invention includes: a plurality of encoding sections for encoding the plurality of moving image signals, the encoding sections being provided with a plurality of quantization sub-sections for quantizing the plurality of moving image signals with predetermined quantization widths; and a quantization control section for controlling the quantization widths used by the quantization sections simultaneously.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION:

The present invention relates to moving image encoding device/method for encoding a plurality of moving images in such a manner that the quality of moving images reproduced by a decoding device is enhanced after the process ofcompressing/encoding the plurality of moving images and multiplexing the encoded signals to generate moving image encoded signals at a constant bit rate.

The present invention also relates to moving image multiplexing device/method for multiplexing moving image encoded signals obtained after the process of compressing/encoding a plurality of moving images or moving image segments obtained by dividing a high-precision moving image.

The present invention further relates to an image transmission device which compresses/encodes a plurality of moving images and transmits the resultant moving image encoded signals at a limited bit rate, used in the moving image transmission for satellite communications or network communications such as a LAN, for example.

2. DESCRIPTION OF THE RELATED ART:

In one of the methods for compressing/encoding and multiplexing a plurality of moving images to transmit the resultant moving images as a bit stream at a constant bit rate, a predetermined fixed bit rate is allocated for each of the moving images so that the sum of the bit amounts representing the plurality of moving images after the compression/encoding constitutes a constant bit rate. In such a method, when moving images with high complexity are input, the allocated bit rate is insufficient, resulting in great degradation in the image quality. Conversely, when moving images with low complexity are input, stuffing increases, resulting in wasteful use of the bit rate. As a result, two opposite problems arise. That is, when an effective use of the bit rate is attempted, the image quality lowers. Conversely, when high image quality is attempted, the bit rate is not effectively used, decreasing the number of moving images which can be multiplexed.

In order to solve the above problems, Japanese Laid-Open Publication No. 8-23540 discloses an encoding control device in which the bit rate at the encoding of respective moving image signals is made variable to improve the quality of moving images reproduced by a decoding device. In this encoding control device, the moving images reproduced from moving image encoded signals are compared with the original moving images. The bit rate is increased when a reproduced moving image is largely distorted from the original one, while it is decreased when a reproduced moving image is little distorted, so that the quality of the moving images is made uniform and thus the entire image quality improves.

According to the above method, however, the bit rate is changed after the amount of distortion is determined. Therefore, in the case where the moving images become complicated suddenly due to a scene change and the like, the quality of the moving image immediately after the scene change is low.

Moreover, in this conventional device in which the bit rate at the encoding of the moving images is variable, when a simple multiplexing operation is conducted such as changing the bit rate in proportion to the bit amount generated during a predetermined time period, an input buffer of a decoding device may cause overflow or underflow.

An encoding device which encodes moving images with different resolutions is disclosed in Japanese Laid-Open Publication No. 6-6777, for example. Figure **37** shows the configuration of such an encoding device, where high-quality HDTV moving images are divided into a plurality of blocks by a frame synthesization blocking section **1101**, and the resultant blocks are sent to a block distribution section **1102**. When a signal switch **1107** which operates in response to an operation mode signal is switched to one terminal connecting with the block distribution section **1102**, the block distribution section **1102** distributes the respective blocks received from the frame synthesization blocking section **1101** to moving image encoding sections **1103** to **1106**. The moving image encoding sections **1103** to **1106** encode the respective blocks and output resultant encoded signals. When the signal switch **1107** is switched to the other terminal, TV moving images with a normal quality are supplied to the moving image encoding section **1103** via the signal switch **1107**. The moving image encoding section **1103** encodes the TV moving images and outputs resultant encoded signals.

Thus, in this conventional device, both low-resolution moving image signals and high-resolution moving image signals can be encoded by switching the signal switch **1107**.

However, the conventional device with the above configuration provides no conception of encoding and multiplexing moving images with different resolutions simultaneously. This device is therefore not applicable to the simultaneous transmission of moving images with different resolutions which is employed in broadcasting and the like.

In one conventional technique of multiplexing a plurality of moving images for transmission, a fixed bit rate is allocated for each encoding device, so that moving images are encoded by each encoding device at the allocated bit

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rate and resultant moving image encoded signals are multiplexed. However, this technique has the following problem. The complexity of moving images changes with time. Accordingly, in order to encode and transmit the moving images so that the degradation in the image quality is always inconspicuous, the respective bit rates are required to be set so that the degradation in the image quality of the reproduced moving image is inconspicuous even when a moving image with highest complexity is encoded. This lowers the transmission efficiency.

In order to solve the above problem, a method in which the bit rate is changed depending on the complexity of the encoding of moving images has been attempted. According to this method, the bit rate is lowered for simple moving images to realize efficient transmission, and multi-channel communication using more channels is possible for the same transmission bit rate. This method is described in WO 95/32565, for example.

Figure 38 shows a device implementing the above method. Referring to Figure **38**, moving image encoding sections **2101**, **2102**, and **2103** encode input moving images in accordance with respective target rates specified by a multiplexing section **2104**, and output resultant encoded signals to the multiplexing section **2104**. The multiplexing section **2104** multiplexes the received encoded signals and outputs multiplexed signals to a transmission route. The multiplexing section **2104** also adjusts the target rates based on a transmission rate for the encoded signals and supplies the new target rates to the moving image encoding sections **2101** to **2103**.

The target rates are set so that a total of the target rates is equal to the transmission rate. More specifically, each of the moving image encoding sections **2101** to **2103** sends the amount of encoding distortion at the encoding to the multiplexing section **2104** every fixed period. The multiplexing section **2104** adjusts the target rate depending on the amount of encoding distortion sent from each of the moving image encoding sections **2101** to **2103** while the total of the target rates is kept equal to the transmission rate. That is, the target rate is increased for the moving image encoding section which has sent a large distortion amount, while it is lowered for the moving image encoding section which has sent a small distortion amount. In this way, moving images encoded by the moving image encoding sections **2101** to **2103** are provided with bit rates allocated depending on the complexity of the encoding.

In the above conventional method, however, the target rates are corrected so as to reduce the amount of distortion after the distortion is generated. Accordingly, the image quality tends to be low at an instance immediately after the scene change to a scene of which encoding is difficult, for example. Moreover, in this conventional method, the multiplexing section calculates the target rates to be allocated to the moving image encoding sections based on the amounts of encoding distortion in the moving image encoding sections. Therefore, when the number of moving image encoding sections connected to the multiplexing section is large, the amount of calculation required to allocate the target rates increases. Furthermore, if the moving image encoding sections are dispersed on a network and moving images are transmitted on the network, processings of collecting information on the encoding distortion from the respective moving image encoding sections and allocating the target rates to the respective moving image encoding sections are required. It is difficult to achieve these processings real time.

SUMMARY OF THE INVENTION

The moving image encoding device for encoding a plurality of moving image signals of this invention includes: a plurality of encoding sections for encoding the plurality of moving image signals, the encoding sections being provided with a plurality of quantization sub-sections for quantizing the plurality of moving image signals with predetermined quantization widths: and a quantization control section for controlling the quantization widths used by the quantization sub-sections simultaneously.

With the above configuration, the quality of the output moving images can be made uniform.

In one embodiment of the invention, the quantization widths used by the quantization sub-sections are the same.

In another embodiment of the invention, the moving image encoding device further includes a plurality of accumulation sections for temporarily accumulating a plurality of moving image encoded signals output from the plurality of encoding sections, wherein the quantization control section determines the quantization widths used by the quantization sub-sections based on a. sum of bit amounts of the plurality of moving image encoded signals accumulated in the accumulation sections.

In still another embodiment of the invention, the moving image encoding device further includes a screen division section disposed upstream of the plurality of encoding sections for dividing an input moving image signal into a plurality of moving image signals.

According to another aspect of the invention, a moving image multiplexing device for multiplexing a plurality of moving image encoded signals obtained by encoding a plurality of moving image signals is provided. The device includes: a plurality of accumulation sections for temporarily accumulating the plurality of moving image encoded signals: a multiplexing section for multiplexing the plurality of moving image encoded signals accumulated in the plurality of accumulation sections and outputting the multiplexed signals at a constant bit rate: a decoding delay time calculation section for calculating a time period from when a specific bit of each of the plurality of moving image encoded signals is input into a decoding device until when the specific bit is decoded by the decoding device: a frame bit amount

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calculation section for calculating a bit amount of a frame including the specific bit of each of the plurality of moving image encoded signals accumulated in the plurality of accumulation sections; and a multiplexing control section for controlling a plurality of first input bit amount which are the bit amounts of the plurality of moving image encoded signals input from the plurality of accumulation sections to the multiplexing section based on calculation results of the decoding delay time calculation section and the frame bit amount calculation section.

With the above configuration, the multiplexing is conducted in constant consideration of the decoding delay time in the decoding device. Accordingly, the occurrence of overflow or underflow can be prevented at the decoding of the moving image encoded signals by the decoding device.

In one embodiment, the -multiplexing control section includes: a first parameter generation subsection for determining a plurality of first parameters each of which is a ratio of the bit amount calculated by the frame bit amount calculation section to the time calculated by the decoding delay time calculation section; a second parameter generation sub-section for determining a second parameter which is a sum of the plurality of first parameters; a third parameter generation sub-section for determining a plurality of third parameters each of which is a ratio of each of the plurality of first parameters to the second parameter for the plurality of moving image encoded signals accumulated in the plurality of accumulation sections; and a multiplex bit amount calculation section for calculating the plurality of first input bit amounts based on the plurality of third parameters.

In one embodiment of the invention, the moving image multiplexing device further includes: an accumulated bit amount calculation section for calculating the bit amounts of the plurality of moving image encoded signals accumulated in the plurality of accumulation sections; and an empty capacity calculation section for calculating an empty capacity of an input buffer of a decoding device immediately before a specific bit of each of the plurality of moving image encoded signals is input into the decoding device, wherein the multiplex bit amount calculation section sets for each of a plurality of second input bit amounts a minimum value among (1) the first input bit amount determined based on the third parameter, (2) the bit amount of the moving image encoded signal calculated by the accumulated bit amount calculation section, and (3) the empty capacity of the input buffer of the decoding device calculated by the empty capacity calculation section, and the multiplex bit amount calculation section controls the bit amounts of the moving image encoded signals sent from the accumulation sections to the multiplexing section based on the plurality of second input bit amounts.

In another embodiment of the invention, when the plurality of second input bit amounts calculated by the multiplex bit amount calculation section are different from the corresponding first input bit amounts, the multiplex bit amount calculation section increases the second input bit amounts.

According to still another aspect of the invention, a moving image encoding method for encoding a plurality of moving image signals simultaneously is provided. The method includes encoding all the plurality of moving image signals with the same quantization width.

Alternatively, the moving image encoding method for encoding a plurality of moving image signals simultaneously of this invention includes encoding the plurality of moving image signals with a quantization width obtained based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and output bit amounts of the plurality of moving image encoded signals output after being temporarily accumulated.

According to still another aspect of the invention, a moving image multiplexing method for multiplexing a plurality of moving image encoded signals after being accumulated in a plurality of accumulatidn sections is provided. The method includes the steps of: (1) calculating a time period from when a specific bit of each of the plurality of moving image encoded signals is input into a decoding device having an input buffer until when the specific bit is decoded: (2) calculating a bit amount of a frame including the specific bit of each of the plurality of moving image encoded signals accumulated in the plurality of accumulation sections; and (3) determining a plurality of multiplex bit amounts to be multiplexed from the plurality of moving image coded signals based on calculation results from steps (1) and (2)

In one embodiment of the invention, step (3) includes the steps of: (4) determining a plurality of first parameters each of which is a ratio of the bit amount obtained in step (2) to the time obtained in step (1): (5) determining a second parameter which is a sum of the plurality of first parameters: (6) determining a plurality of third parameters each of which is a ratio of each of the plurality of first parameters to the second parameter for the plurality of moving image encoded signals; and (7) determining the plurality of multiplex bit amounts based on the plurality of third parameters.

In still another embodiment of the invention, an input multiplex bit amount used for multiplexing each of the plurality of moving image encoded signals is set at a minimum value among (1) the multiplex bit amount determined based on the third parameter, (2) the bit amount of the moving image encoded signal accumulated in the accumulation section, and (3) an empty capacity of the input buffer of the decoding device, and each of the bit amounts to be multiplexed is controlled using the input multiplex bit amount.

In still another embodiment of the invention, when at least one of the input multiplex bit amounts is different from the corresponding multiplex bit amount, the input multiplex bit amount is increased.

Alternatively, in the moving image multiplexing method for multiplexing a plurality of moving image encoded signals

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of this invention, a plurality of multiplex bit amounts corresponding to the plurality of moving image encoded signals is preset at zero. The method includes the steps of: (1) calculating a frame bit amount of a frame including a specific bit of each of the plurality of moving image encoded signals; (2) calculating a time period until each of the plurality of moving image encoded signals is decoded; (3) selecting the moving image encoded signal where the time period obtained in step (2) is shorter than a predetermined time value; (4) determining a plurality of primary multiplex bit amounts based on the frame bit amount of the moving image encoded signal selected in step (3); (5) calculating a sum of the plurality of primary multiplex bit amounts; (6) adding the plurality of primary multiplex bit amounts to the plurality of multiplex bit amounts; and (7) renewing the predetermined time value, wherein steps (1) to (7) are repeated, and, if the sum of the plurality of primary multiplex bit amounts is larger than a predetermined bit amount, a plurality of secondary multiplex bit amounts are determined and added to the plurality of multiplex bit amounts, to multiplex the moving image encoded signals of the plurality of multiplex bit amounts.

Thus, since the moving image encoded signals are multiplexed in such a manner that the encoded signal of the frame which will be decoded earlier is multiplexed earlier, the occurrence of overflow or underflow is prevented at the decoding of the moving image encoded signals by the decoding device.

Alternatively, the moving image multiplexing method for multiplexing a plurality of moving image encoded signals of this invention includes the steps of: determining a plurality of minimum transmission amounts required for preventing underflow of a plurality of input buffers of decoding devices based on bit amounts of frames of the plurality of moving image encoded signals which have not been transmitted to the decoding devices and times required until the frames of the plurality of moving image encoded signals are decoded; determining a plurality of transmission bit amount lower limits based on the plurality of minimum transmission amounts; and multiplexing the plurality of transmission bit amount lower limits before multiplexing the plurality of moving image encoded signals.

Alternatively, the moving image encoding device for encoding a plurality of moving image signals of this invention includes: a plurality of encoding sections for encoding the plurality of moving image signals, each of the plurality of encoding sections including a quantization sub-section for quantizing the moving image signals with a predetermined parameter and a stuffing sub-section for stuffing the quantized moving image signals with a predetermined stuffing amount; a quantization control section for controlling the parameters used by the quantization sub-sections simultaneously; a plurality of accumulation sections for temporarily accumulating a plurality of moving image encoded signals output from the plurality of encoding sections; a multiplexing section for multiplexing the plurality of moving image encoded signals accumulated in the plurality of accumulation sections and outputting the multiplexed signals at a constant bit rate; a stuffing control section for controlling the stuffing amounts used by the stuffing sections; and a virtual empty capacity calculation section for calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the plurality of moving image encoded signals are not input into the input buffers for the predetermined time period, wherein the quantization control section determines the parameters used by the quantization sub-sections based on a sum of the bit amounts of the plurality of moving image encoded signals, and the stuffing control section controls each of the stuffing sections based on a sum of the bit amounts of the moving image encoded signals accumulated in the plurality of accumulation sections, the constant bit rate, and a difference between the bit amount of each of the moving image encoded signals accumulated in the accumulation section and the empty capacity of the input buffer obtained by the virtual empty capacity calculation section.

Alternatively, the moving image encoding method of this invention encodes a plurality of moving image signals simultaneously using predetermined quantization widths each based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and an output bit amount of each of the plurality of moving image encoded signals output after being temporarily accumulated, wherein a plurality of encoded buffer occupations of the moving image encoded signals temporarily accumulated are calculated, an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the moving image encoded signals are not input into the input buffers for the predetermined time period is calculated; and for each of the moving image encoded signals where a buffer differential value obtained by subtracting the empty capacity of the input buffer from the encoded buffer occupation is smaller than a predetermined value, a signal of a bit amount obtained by adding the buffer differential value larger than the predetermined value which does not influence the encoding is distributed to the moving image encoded signals where the buffer differential value is smaller than the predetermined value to effect stuffing.

In one embodiment, the predetermined value is 0.

Alternatively, the moving image encoding device for encoding a plurality of moving image signals of this invention includes: a plurality of encoding sections for encoding the plurality of moving image signals, each of the plurality of encoding sections including a quantization sub-section for quantizing the moving image signals with a predetermined parameter; a quantization control section for controlling the parameters used by the quantization sub-sections simultaneously; a plurality of accumulation sections for temporarily accumulating a plurality of moving image encoded signals output from the plurality of encoding sections; a multiplexing section for multiplexing the plurality of moving image

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encoded signals accumulated in the plurality of accumulation sections and outputting the multiplexed signals at a constant bit rate; a virtual empty capacity calculation section for calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the plurality of moving image encoded signals are not input into the input buffers for the predetermined time period, wherein the quantization control section determines each of the parameters used by the quantization sub-sections based on a sum of the bit amounts of the moving image encoded signals accumulated in the plurality of accumulation sections, the constant bit rate, and a difference between the bit amount of the moving image encoded signal accumulated in the accumulation section and the empty capacity of the input buffer obtained by the virtual empty capacity calculation section.

Alternatively, the moving image encoding method of this invention encodes a plurality of moving image signals simultaneously using predetermined quantization widths each based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and an output bit amount of each the plurality of moving image encoded signals output after being temporarily accumulated. The method includes the steps of: calculating a plurality of encoded buffer occupations of the moving image encoded signals temporarily accumulated, calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the moving image encoded signals are not input into the input buffers for the predetermined time period; and encoding each of the moving image encoded signals where a buffer differential value obtained by subtracting the empty capacity of the input buffer from the encoded buffer occupation is smaller than a predetermined value using a quantization width smaller than the corresponding predetermined quantization width.

Thus, even when the generated bit amount of the moving image signal suddenly increases because a corresponding portion of an image is extremely complicated, the occurrence of underflow in the input buffer at the decoding of the moving image encoded signals by the decoding device is prevented.

In one embodiment of the invention, the predetermined value is 0.

Alternatively, the moving image encoding method of this invention encodes a plurality of moving image signals simultaneously using predetermined quantization widths each based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and an output bit amount of each the plurality of moving image encoded signals output after being temporarily accumulated. The method includes the steps of: calculating a plurality of encoded buffer occupations of the moving image encoded signals temporarily accumulated, calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the moving image encoded signals are not input into the input buffers for the predetermined time period; and encoding each of the moving image encoded signals where a buffer differential value obtained by subtracting the empty capacity of the input buffer from the encoded buffer occupation is larger than a predetermined value using a quantization width larger than the corresponding predetermined quantization width.

In one embodiment of the invention, the predetermined value is 0.

Alternatively, the moving image encoding method of this invention encodes a plurality of moving image signals simultaneously using predetermined quantization widths each based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and an output bit amount of each the plurality of moving image encoded signals output after being temporarily accumulated, comprising the steps of: calculating a plurality of encoded buffer occupations of the moving image encoded signals temporarily accumulated, calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the moving image encoded signals are not input into the input buffers for the predetermined time period; and calculating a buffer differential value obtained by subtracting the empty capacity of the input buffer from the encoded buffer occupation for each of the moving image encoded signals, and adding a sum of the buffer differential values which are larger than a predetermined value to the sum of the bit amounts.

In one embodiment of the invention, the predetermined value is 0.

According to still another aspect of the invention, the moving image encoding and multiplexing device for encoding a plurality of moving image signals and multiplexing the encoded signals is provided. The device includes: a moving image switch section for switching a destination of a plurality of input moving images; a plurality of encoding sections for encoding the plurality of input moving images output from the moving image switch section; a multiplexing section for multiplexing the encoded signals output from the plurality of encoding sections; and a control section for switching a switching state of the moving image switch section, an encoding mode of the encoding sections, and a multiplexing mode of the multiplexing sections; wherein the control section switches the encoding mode of the encoding sections and the multiplexing mode of the multiplexing sections depending on the switching state of the moving image switch section.

With the above configuration, the plurality of moving image signals with different precisions can be simultaneously encoded, multiplexed, and output. At this time, the combination of the numbers of input moving image signals for respective levels of precision is not restricted. The simultaneous encoding and multiplexing is also applicable to the cases where all the input moving image signals are independent from one another or all the input moving image signals are generated by screen division. Also, even when the output bit rate after the multiplexing is constant, it is possible

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to simultaneously encode, multiplex, and output the plurality of individual moving image signals and the plurality of moving image signals generated from one moving image signal by screen division.

In one embodiment of the invention, the control section comprises: a switch control sub-section for switching the switching state of the moving image switch section; an encoding control sub-section for switching the encoding mode of the encoding section; and a multiplexing control sub-section for switching the multiplexing mode of the multiplexing section, and the encoding control sub-section switches the encoding mode depending on the switching state of the moving image switch section, and the multiplexing control sub-section switches the multiplexing mode depending on the switching state of the moving image switch section.

In still another embodiment of the invention, the moving image encoding and multiplexing device further includes a screen division section upstream of the moving image switch section.

In still another embodiment of the invention, the moving image encoding and multiplexing device further includes a moving image time-division section upstream of the moving image switch section.

In still another embodiment of the invention, the moving image encoding and multiplexing device further includes accumulation sections for temporarily accumulating moving image encoded signals output from the encoding sections, wherein the encoding control sub-section determines a parameter for controlling each of the encoding sections based on a sum of bit amounts of the moving image encoded signals accumulated in the accumulation sections.

In still another embodiment of the invention, the multiplexing section comprises: a moving image multiplexing sub-section for multiplexing the plurality of moving image encoded signals and outputting a moving image encoded signal; a channel multiplexing sub-section for multiplexing a plurality of input signals input into the multiplexing section and the output signal output from the moving image multiplexing sub-section; and a switch sub-section for switching the destination of the moving image encoded signals input into the multiplexing section between the moving image multiplexing sub-section and the channel multiplexing sub-section.

According to still another aspect of the invention, an image transmission device is provided. The device includes a plurality of image encoding sections and a transmission processing section, wherein the transmission processing section multiplexes encoded data specified by the image encoding sections every multiplexing timing, transmits the encoded data to a predetermined route, and sends to the image encoding sections multiplexing information which is calculated based on encoded data amount in the image encoding sections and can be used for calculation of a delay amount taken until the encoded data is transmitted to a decoding device, and the plurality of image encoding sections determine quantization widths used at quantization in an image encoding processing based on the multiplexing information sent from the transmission processing section, encode the images, and transmit the encoded data to the transmission processing section every multiplexing timing to specify the encoded data.

In one embodiment of the invention, the transmission processing section comprises a transmission buffer, and the transmission processing section takes the encoded data specified by the image encoding sections in the transmission buffer every multiplexing timing, and outputs the encoded data at a predetermined transmission rate in the order of the taking-in of the encoded data, as well as outputting an occupation of the encoded data in the transmission buffer as multiplexing information.

In one embodiment of the invention, each of the image encoding sections includes: a quantization width determination sub-section; and a basic encoding processing sub-section for encoding images by quantizing the images with a quantization width specified by the quantization width determination sub-section, and the quantization width determination sub-section calculates a buffer occupation in each of a plurality of decoding devices which receive the encoded data transmitted from each of the image encoding sections via the transmission processing section based on the multiplexing information, and sets the quantization width based on the calculated buffer occupation in the decoding device and an amount of encoded data which has not been transmitted.

In another embodiment of the invention, each of the image encoding sections further includes an encoded data memory sub-section for temporarily storing the encoded data, and the encoded data memory sub-section temporarily stores non-transmitted data which has not been transmitted to the transmission processing section among the encoded data every transmission timing, and transmits the encoded data to the transmission processing section using as an upper limit a value preset by each of the image encoding sections or a value obtained by subtracting the buffer occupation in the decoding device calculated based on the multiplexing information from a buffer size of the decoding device predicted by the receiver side.

Alternatively, the image transmission device of this invention includes a transmission processing section for receiving encoded data from a plurality of image encoding sections, wherein the transmission processing section comprises a transmission buffer, takes the encoded data specified by the image encoding sections in the transmission buffer every multiplexing timing, and outputs the encoded data at a predetermined transmission rate in the order of the taking-in of the encoded data, as well as outputting an occupation of the encoded data in the transmission buffer as multiplexing information.

Alternatively, the image encoding device of this invention includes a quantization width determination section and a basic encoding processing section for encoding images by quantizing the images with a quantization width specified

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by the quantization width determination section, wherein the quantization width determination section determines the quantization width based on multiplexing information which can be used for calculation of a delay amount taken until encoded data is transmitted to a virtual decoding device, a buffer occupation in the virtual decoding device calculated based on the multiplexing information, and an amount of encoded data which has not been transmitted.

In one embodiment of the invention, the image encoding device further includes an encoded data memory section for temporarily storing the encoded data, wherein the encoded data memory section temporarily stores non-transmitted data which has not been transmitted among the encoded data every transmission timing, and outputs the encoded data using as an upper limit a value preset by each of the image encoding sections or a value obtained by subtracting the buffer occupation in the virtual decoding device calculated based on the multiplexing information from a buffer size of the decoding device predicted by the receiver side.

Alternatively, the image transmission device of this invention includes a bit rate management section for managing a bit rate at a transmission route and one or more image encoding sections; wherein the bit rate management section determines a bit rate representing a total of transmission rates at the one or more image encoding sections on the transmission route, allows for transmission of encoded data requested to be transmitted by any of the image encoding sections every transmission timing, and sends transmission information regarding a transmission delay which varies with the allowance to another image encoding section on the transmission route, and the one or more image encoding sections encode images by quantizing the images with a quantization width determined based on the transmission information, non-transmitted encoded data, and a predicted buffer size on the receiver side.

With the above configuration, the image quality of the image signals transmitted on a network can be made substantially uniform.

Alternatively, the image transmission device of this invention includes a bit rate management section for managing transmission rates of a plurality of image encoding sections, wherein the bit rate management section determines a bit rate representing a total of transmission rates at all the image encoding sections on a transmission route, allows for transmission of encoded data requested to be transmitted by any of the image encoding sections every transmission timing, and sends transmission information regarding a transmission delay which varies with the allowance to another one of the image encoding sections on the transmission route.

Alternatively, the image encoding device of this invention sets a quantization width used for quantization based on transmission information regarding a transmission delay which varies with an allowable transmission amount, non-transmitted encoded data, and a predicted buffer size on the receiver side.

Alternatively, the image encoding method of this invention includes the steps of: (1) determining a quantization width; and (2) encoding images by quantizing the images with the quantization width specified in step (1), wherein in step (1) the quantization width is set based on multiplexing information which can be used to calculate a delay amount taken until encoded data is transmitted to a virtual decoding device, a buffer occupation in the virtual decoding device calculated based on the multiplexing information, and an amount of encoded data which has not been transmitted.

In one embodiment of the invention, non-transmitted data which has not been transmitted among the encoded data is temporarily stored every transmission timing, and the encoded data is output using as an upper limit a value preset by each of the image encoding sections or a value obtained by subtracting the buffer occupation in the decoding device calculated based on the multiplexing information from the buffer size of the decoding device predicted by the receiver side.

Alternatively, the image encoding method of this invention includes encoding images by setting a quantization width used for quantization based on transmission information regarding a transmission delay which varies with an allowable transmission amount, non-transmitted encoded data, and a predicted buffer size on the receiver side.

Thus, the invention described herein makes possible the advantages of: (1) providing moving image encoding device/method which output moving images with a uniform quality and prevent the image quality from largely lowering even immediately after a scene change at which the images suddenly become complicated; (2) providing moving image multiplexing device/method which multiplex moving image signals and output the results so that each input buffer of a decoding device does not overflow or underflow; (3) providing moving image encoding and multiplexing device/method which encode moving image signals with different resolutions simultaneously, multiplex the encoded signals, and output the results; and (4) providing an image transmission device in which the quality of images encoded by encoding sections is kept uniform even at a scene change, and, in an application of having encoders dispersed in a network, bit rates are allocated for the encoders depending on the images input therein within the range of an allowable entire bit rate and a uniform image quality is obtained.

These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure **1** is a block diagram of a moving image encoding and multiplexing device of Example 1 according to the

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present invention.

Figure **2** is a block diagram of an encoding section of the device of Figure **1**.

Figure **3** is a block diagram of a multiplexing control section of the device of Figure **1**.

Figure **4** is a graph showing the quantization width with respect to the bit amount in accumulation sections.

Figure **5** is a block diagram of a moving image encoding and multiplexing device of Example **2** according to the present invention.

Figure **6** is a block diagram of a multiplexing control section of the device of Figure **5**.

Figure **7** is a flowchart showing the operation of the device of Figure **5**.

Figure **8** is a flowchart showing the processing at step **204** in Figure **7**.

Figure **9** is a flowchart showing the processing at step **208** in Figure **7**.

Figure **10** is a flowchart showing the operation of a moving image encoding and multiplexing device of Example 3 according to the present invention.

Figures **11A** to **11C** are graphs for illustrating the processing at step **502** in Figure **10** where the lower limit of the transmission amount is calculated.

Figure **12** is a block diagram of a moving image encoding and multiplexing device of Example 4 according to the present invention.

Figure **13** is a block diagram of an encoding section of the device of Figure **12**.

Figures **14A** and **14B** are views for illustrating the calculation by a decoder buffer empty capacity calculation section of the device of Figure **12**.

Figure **15** is a flowchart showing the operation of a stuffing control section of the device of Figure **12**.

Figure **16** is a block diagram of a moving image encoding and multiplexing device of Example 5 according to the present invention.

Figure **17** is a block diagram of a moving image encoding and multiplexing device of Example 7 according to the present invention.

Figure **18** is a block diagram of a moving image encoding and multiplexing device of Example 8 according to the present invention.

Figure **19** is a schematic view showing a screen division method employed by the device of Figure **18**.

Figure **20** is a block diagram of a moving image encoding and multiplexing device of Example 9 according to the present invention.

Figure **21** is a block diagram of a multiplexing section of the device of Figure **20**.

Figure **22** is a block diagram of a moving image encoding and multiplexing device of Example 10 according to the present invention.

Figure **23** is a block diagram of a moving image encoding and multiplexing device of Example 11 according to the present invention.

Figure **24** is a block diagram of a moving image encoding and multiplexing device of Example 12 according to the present invention.

Figure **25** is a block diagram of an image transmission device of Example 13 according to the present invention.

Figure **26** is a block diagram of an encoding sub-section of an image encoding section of the device of Figure **25**.

Figure **27** is a flowchart showing the operation of the encoding sub-section of Figure **26**.

Figure **28** is a schematic block diagram of an image transmission device of Example 14 according to the present invention.

Figure **29** shows a header format of a packet used in the device of Figure **28**.

Figure **30** is a view for illustrating a communication method between nodes of the device of Figure **28**.

Figure **31** is a view for illustrating the transmission of a packet for notifying the number of packets used in the device of Figure **28**.

Figure **32** is a view for illustrating the transmission of a packet for image transmission used in the device of Figure **28**.

Figure **33** is a view for illustrating the transmission of packets generated by a bit rate management node of the device of Figure **28**.

Figure **34** is a block diagram of nodes of the device of Figure **28**.

Figures **35A** and **35B** are graphs comparing the utilization of the bit rate between a conventional device and the device of Figure **28**.

Figure **36** schematically shows an implementation of the present invention by using general computers.

Figure **37** is a block diagram of a conventional moving image encoding device.

Figure **38** is a block diagram of a conventional image transmission device.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described by way of examples with reference to the accompanying drawings.

(Example 1)

Figure 1 is a block diagram of a moving image encoding and multiplexing device of Example 1 according to the present invention.

The moving image encoding and multiplexing device of this example includes: encoding sections **1-1A** to **1-NA** (where N is an integer) which compress/encode input moving images by signal transformation and quantization; accumulation sections **2-1** to **2-N** which accumulate moving image encoded signals output from the encoding sections **1-1A** to **1-NA**; a multiplexing section 3 which multiplexes the moving image encoded signals and outputs resultant multiplexed signals at a constant bit rate; a quantization control section **4** which controls a quantization width used at the quantization by the encoding sections **1-1A** to **1-NA**; a decoding delay time calculation section **5** which calculates the time period from the input of one bit of each of the moving image encoding signals into a decoding device until the decoding of the bit (decoding delay time); a frame bit amount calculation section **6** which calculates the bit amount in each of frames composed of the moving image encoded signals accumulated in the accumulation sections **2-1** to **2-N**; a multiplexing control section **7A** which controls the multiplexing section **3**; and an adder **8** which sums up the number of bit amounts of the moving image encoded signals accumulated in the accumulation sections **2-1** to **2-N**.

Figure **2** is an exemplified configuration of the encoding section **1-1A** shown in Figure **1**. When a moving image signal representing a moving image is input into the encoding section **1-1A**, a differentiator 101-1 calculates the difference between the input moving image and the moving image of one frame accumulated of a frame memory **108-1**, and outputs a differential moving image. The differential moving image is then transformed into a DCT (discrete cosine transformation) coefficient by a DCT sub-section **102-1**. The DCT coefficient is then quantified with the quantization width specified by the quantization control section **4** by a quantization sub-section **103-1** and transformed into the moving image encoded signal by a variable length encoding sub-section **104-1**. The resultant moving image encoded signal is output from the encoding section **1-1A**. The output signal from the quantization sub-section **103-1** is also supplied to a reverse quantization sub-section **105-1**, where the input signal is reverse-quantified. The reverse-quantified signal is transformed into a decoding differential moving image by a reverse DCT sub-section **106-1**. The decoding differential moving image is added with the moving image of one frame accumulated in the frame memory **108-1**. to be transformed into a moving image which is to be decoded by the decoding device. The resultant moving image is accumulated in the frame memory **108-1**.

The decoding delay time calculation section **5** calculates the decoding delay time of the bit of the moving image encoded signal accumulated in each of the accumulation sections **2-1** to **2-N** which is initially sent to the multiplexing section **3**. The decoding delay time of the bit which is initially output from each of the encoding sections **1-1A** to **1-NA** is used as the initial value. This is predetermined based on the size of an input buffer of the decoding device, the output bit rate at the multiplexing section **3**, and the like. Thereafter, the value is renewed in accordance with the decoding procedure in the decoding device.

The frame bit amount calculation section **6** calculates the bit amount of a frame including the bit of the moving image encoded signal accumulated in each of the accumulation sections **2-1** to **2-N** which is initially sent to the multiplexing section **3**.

The multiplexing control section **7A** repeats the calculation of the bit amount of the moving image encoded signal output from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3** at a predetermined period.

The multiplexing section **3** multiplexes the moving image encoded signals based on the bit amounts calculated by the multiplexing control section **7A**, and outputs the multiplexed signals at a constant bit rate.

Figure **3** is an exemplified configuration of the multiplexing control section **7A** in Figure **1**. A first parameter generation sub-section **71** receives the bit amount of a frame including the bit of the accumulated moving image encoded signal which is initially sent to the multiplexing section **3**, together with the decoding delay time, for each of the accumulation sections **2-1** to **2-N**. and divides the bit amount of the frame by the decoding delay time. A second parameter generation sub-section **72** sums up the values obtained by the first parameter generation sub-section **71** for the accumulation sections **2-1** to **2-N**. A third parameter generation sub-section **73** divides the respective values obtained by the first parameter generation sub-section **71** by the value obtained by the second parameter generation sub-section **72** for the accumulation section **2-1** to **2-N**. A multiplex bit amount calculation sub-section **74** receives the bit amount of the moving image encoded signals output from the multiplexing section **3** during the period when the bit amounts output from the accumulation sections **2-1** to **2-N** to the multiplexing section **3** are calculated, multiplies the received bit amount by the value obtained by the third parameter generation sub-section **73** for each of the accumulation sections **2-1** to **2-N**, and notifies the multiplexing section **3** of the resultant value as the bit amount to be output from each of the accumulation section **2-1** to **2-N** to the multiplexing section **3**.

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The operation of the device of Example 1 described above can be summarized as follows. The moving image encoded signals output from the encoding sections **1-1A** to **1-NA** are temporarily accumulated in the accumulation sections **2-1** to **2-N**. The bit amounts of the moving image encoded signals accumulated in the accumulation sections **2-1** to **2-N** are summed up by the adder **8**, and the resultant value is sent to the quantization control section **4**. The quantization control section **4** calculates the quantization width based on the received value, i.e., the sum of the bit amounts of the moving image encoded signals, and the moving images are quantified based on the quantization width. The multiplexing control section **7A** calculates the bit amounts to be output from the accumulation sections **2-1** to **2-N** to the multiplexing section **3** using the values obtained by the decoding delay time calculation section **5** and the frame bit amount calculation section **6**. The multiplexing section **3** multiplexes the moving image encoded signals using the bit amounts obtained by the multiplexing control section **7A**, and outputs the resultant moving image encoded signals at a constant bit rate.

In the above operation, the quantization control section **4** transforms the sum of the bit amounts of the moving image encoded signals into the quantization width. Figure **4** is a graph showing an example of this transformation. The x-axis of this graph represents the sum of the bit amounts of the moving image encoded signals accumulated in the accumulation sections **2-1** to **2-N**, which is equal to the difference between the sum of the bit amounts of the moving image encoded signals generated by the encoding and the bit amounts of the moving image encoded signals output from the accumulation sections **2-1** to **2-N** calculated from the bit rates. The y-axis of the graph represents the quantization width. In this example, it is set so that the quantization width is larger as the bit amount is larger, and it is smaller as the bit amount is smaller.

The quantization control section **4** calculates the quantization width based on the characteristics shown in the graph of Figure **4**, and supplies the quantization width to all the encoding sections **1-1A** to **1-NA**. In other words, all the encoding sections **1-1A** to **1-NA** have the same value as the quantization width and conducts the quantization based on this quantization width.

As described above, in Example 1, since a plurality of input moving images are compressed/encoded using the same quantization width, the quality of a plurality of output moving images can be made uniform. Moreover, since the quantization control is conducted based on the sum of the bit amounts of the moving image encoded signals accumulated in the accumulation sections **2-1** to **2-N**, the bit rate can be effectively used.

Each of the moving images input into the encoding sections **1-1A** to **1-NA** may constitute one independent moving image or one block composed of segments obtained by dividing one moving image. In the latter case, each block is considered as one frame unit.

In Example 1, all the encoding sections **1-1A** to **1-NA** are controlled with the same quantization width. Alternatively, different quantization widths may be used by providing a restriction, such as setting the priority for the encoding sections **1-1A** to **1-NA** and setting an upper limit for the output bit rate for the moving image encoded signals output from the accumulation sections **2-1** to **2-N.**

(Example 2)

Figure **5** is a block diagram of a moving image encoding and multiplexing device of Example 2 according to the present invention.

In Example 2, two sections are additionally provided to the device of Example 1 shown in Figure **1**: that is, a decoder buffer empty capacity calculation section **9** which determines the current empty capacity of an input buffer of a decoding device, and an accumulated bit amount calculation section **12** which calculates the respective bit amounts accumulated in the accumulation sections **2-1** to **2-N**.

The decoder buffer empty capacity calculation section **9** includes a timer, and receives the bit amount output from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3** from a multiplexing control section **7B** to add the received bit amount to the occupation amount in the input buffer of a virtual decoding device for each of the accumulation sections **2-1** to **2-N**. The decoder buffer empty capacity calculation section **9** also receives the bit amount in each frame input into the input buffer of the decoding device from the frame bit amount calculation section **6** and receives the decoding delay time of each frame from the decoding delay time calculation section **5**. The time at which the decoding of the frame is started is determined based on the decoding delay time for the frame. When the timer indicates that the decoding time is up, the decoder buffer empty capacity calculation section **9** subtracts the bit amount of the frame to be decoded from the occupation amount in the input buffer of the decoding device, subtracts the resultant occupation amount in the input buffer from the capacity of the input buffer, and outputs the resultant value to the multiplexing control section **7B** as the current empty capacity of the input buffer of the decoding device.

Figure **6** shows an exemplified configuration of the multiplexing control section **7B**. A minimum value selection sub-section **75** is additionally provided downstream of the multiplex bit amount calculation sub-section **74** of the multiplexing control section **7A** of Example 1 shown in Figure **3**. The minimum value selection sub-section **75** selects the minimum value among the product obtained by the multiplex bit amount calculation section **74**, the current decoder

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buffer empty volume obtained by the decoder buffer empty capacity calculation section **9**, and the accumulated bit amount in each accumulation section obtained by the accumulated bit amount calculation section **12**, and sends the resultant value to the multiplexing section **3** as the bit amount to be output from the accumulation section to the multiplexing section **3** (hereinafter, such a bit amount is referred to as the multiplex bit amount).

Figure **7** is a flowchart showing the operation of the multiplexing control section **7B** for determining the bit amount of the moving image encoded signal output from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3**.

First, the multiplexing control section **7B** calculates a bit amount of the moving image encoded signals to be output from the multiplexing section **3** every calculation period of the multiplexing control section **7B** based on a predetermined output bit rate at the multiplexing section **3** (step **201**). Then, the decoding delay time for each of the accumulation sections **2-1** to **2-N** is received from the decoding delay time calculation section **5** (step **202**). The bit amount in each frame for each of the accumulation sections **2-1** to **2-N** is obtained from the frame bit amount calculation section **6** (step **203**). A primary multiplex bit amount is calculated for each of the accumulation sections **2-1** to **2-N** in the procedure described later (step **204**). Then, the bit amount of the moving image encoded signal accumulated in each of the accumulation sections **2-1** to **2-N** is obtained from the accumulated bit amount calculation section **12** (step **205**). Thereafter, the input buffer empty capacity calculated by subtracting the bit amount accumulated in the input buffer of the decoding device from the capacity of the input buffer is obtained from the decoder buffer empty capacity calculation section **9** for each of the accumulation sections **2-1** to **2-N** (step **206**). Subsequently, the minimum value among the primary multiplex bit amount obtained at step **204**, the bit amount obtained at step **205**, and the input buffer empty capacity obtained at step **206** is selected to use as a secondary multiplex bit amount (step **207**). Finally, the bit amount of the moving image encoded signal output from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3** is calculated in the procedure described later (step **208**). The above processings are repeated.

Figure **8** is a flowchart showing the processing at step **204** for calculating the primary multiplex bit amount shown in Figure **7** in detail.

First, the bit amount of the moving image encoded signal of a frame accumulated in each of the accumulation sections **2-1** to **2-N** is divided by the decoding delay time, and the resultant value is denoted by R_i (i = 1 to N) (step **301**). Then, the sum R of the values R_1 to R_N is calculated (step **302**). The primary multiplex bit amount $P1_i$ is then calculated by formula (I) below for each of the moving image encoded signals (step **303**).

$$P1i = \frac{Ri}{R} \times \text{moving image output bit amount} \quad (1)$$

Thereafter, the minimum value among the primary multiplex bit amount $P1_i$, the bit amount obtained at step **205**, and the input buffer empty capacity obtained at step **206** is selected for each of the accumulation sections **2-1** to **2-N** to use as a secondary multiplex bit amount $P2_i$.

Figure **9** is a flowchart showing the processing at step **208** for calculating the bit amount of the moving image encoded signal output from each of the accumulation section **2-1** to **2-N** to the multiplexing section **3** shown in Figure **7** in detail.

First, if the primary multiplex bit amount $P1_i$ and the secondary multiplex bit amount $P2_i$ are the same for all the moving image encoded signals accumulated in the accumulation sections **2-1** to **2-N**, the process is terminated (step **401**). Otherwise, whether or not the bit amounts $P1_i$ and $P2_i$ are the same is determined for each of the moving image encoded signals (step **402**). If they are the same, a multiplex bit amount $P3_i$ is calculated by formula (2) below, in addition to the secondary multiplex bit amount $P2_i$ obtained at step **207** (step **403**).

$$P3i = \min(\text{Encoder buffer occupation, decoder buffer empty capacity}) - P2i \quad (2)$$

wherein min indicates that the smaller value between the bit amount obtained at step **205** and the input buffer empty capacity obtained at step **206** is used.

If the bit amounts $P1_i$ and $P2_i$ are not the same, the bit amount $P3_i$ is set at 0 (step **404**). Then, a short bit amount D of the sum of the secondary multiplex bit amounts $P2_i$ for the accumulation sections **2-1** to **2-N** obtained at step **207** in comparison with the bit amount output from the multiplexing section **3** is calculated by formula (3) below (step **405**).

$$D = \text{Output bit amount} - \Sigma P2i \quad (3)$$

Thereafter, the sum S of the bit amounts $P3_i$ obtained at steps **403** and **404** is calculated (step **406**). Whether or not the sum S is larger than the short bit amount D is examined (step **407**). If yes, the multiplex bit amount of the moving

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image encoded signal is set at formula (4) below (step **408**). If no, it is set at formula (5) below (step **409**).

$$\text{Multiplex bit amount} = P2i + P3i \tag{4}$$

$$\text{Multiplex bit amount} = P2i + (D \times \frac{P3i}{S}) \tag{5}$$

Thus. in Example 2, the multiplexing of the moving image encoded signals accumulated in the accumulation sections **2-1** to **2-N** is controlled based on the bit amount in each frame and the time at which each frame should be input into the corresponding decoding device. Accordingly, underflow in the input buffer of the decoding device is prevented. Moreover, the bit amount accumulated in the input buffer of each decoding device is calculated to control the multiplexing so as not to transmit a bit amount exceeding the empty capacity of the input buffer. Accordingly, overflow in the input buffer is prevented.

(Example 3)

Figure **10** is a flowchart showing the operation of a moving image encoding and multiplexing device of Example 3 according to the present invention. The device of Example 3 is the same in the configuration as the device of Example 1 shown in Figure **1**, but different in the processings from the device of Example 1.

The flowchart of Figure **10** shows the operation of the multiplexing control section **7A** determining the multiplex bit amount, i.e., the bit amount of the moving image encoded signal output from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3**.

First, the multiplexing control section **7A** calculates the total bit amount of the moving image encoded signal output from the multiplexing section **3** every calculation period of the multiplexing control section **7A** based on a predetermined output bit rate at the multiplexing section **3** (step **501**). Then, the lower limit of the transmission amount of the moving image encoded signal for each of the accumulation sections **2-1** to **2-N** is calculated in the procedure described later (step **502**), and the moving image encoded signal of the lower-limit bit amount is output from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3**. An initial value is set for a reference time for comparison used to select frames in each of the accumulation sections **2-1** to **2-N** sequentially in such a manner that one with a smaller decoding delay time is selected earlier (step **503**). The bit amount in a head frame in each of the accumulation sections **2-1** to **2-N** is read from the frame bit amount calculation section **6** (step **504**). The decoding delay time of the head frame in each of the accumulation sections **2-1** to **2-N** is read from the decoding delay time calculation section **5** (step **505**). The received decoding delay time of each frame and the reference time are compared (step **506**). For the accumulation section which has accumulated the frame of which decoding delay time is shorter than the reference time, the empty capacity of the input buffer of the corresponding decoding device is first calculated (step **507**). Then, the minimum value among the bit amount of the frame obtained at step **504**, the input buffer empty capacity obtained at step **507**, and the maximum transmission bit amount determined by the maximum output bit rate of the moving image encoded signal is selected to use as the primary multiplex bit amount. For the accumulation section which has accumulated the frame of which decoding delay time is longer than the reference time, the primary multiplex bit amount is set at 0 (step **508**). Then, the sum of the resultant primary multiplex bit amounts for each of the accumulation sections **2-1** to **2-N** is calculated. If the sum is 0, the period of the multiplex bit amount calculation is terminated (step **509**). If the sum is smaller than the remaining bit amount after subtracting the lower limit obtained at step **502** from the total bit amount obtained at step **501**, the primary multiplex bit amount obtained at step **508** is added to the multiplex bit amount for each of the accumulation sections **2-1** to **2-N** (step **511**), and the reference time is renewed by adding the frame period time to the reference time, for example (step **512**). At this time, the moving image encoded signal of the primary multiplex bit amount is output from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3**. If the sum of the primary multiplex bit amounts is larger than the remaining bit amount, values obtained by the proportional distribution depending on the primary multiplex bit amounts are used as the secondary multiplex bit amounts (step **513**), and these secondary multiplex bit amounts are added to the multiplex bit amounts (step **514**), thereby terminating the period of the multiplex bit amount calculation. At this time, the moving image encoded signal of the secondary multiplex bit amount is output from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3**. The above processings are repeated sequentially.

The processing at step **502** for calculating the lower limit of the transmission amount shown in Figure **10** will be described with reference to the graphs of Figures **11A** to **11C**. Figure **11C** is an enlarged partial view of the graph of Figure **11B**.

The graphs in Figures **11A** to **11C** are based on the bit amount of each frame accumulated in the buffer (the accumulation section located downstream of the coding section or the buffer of the decoding device) at a certain time.

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The x-axis of these graphs represents the time axis to show the time period required for a frame in the buffer to be decoded. Each flat portion of property X represents one frame period. The y-axis represents the bit amount: The value below 0 represents the bit amount of the moving image encoded signal accumulated in the buffer of the decoding device. while the value equal to or more than 0 represents the bit amount of the moving image encoded signal accumulated in the buffer of the encoding device.

The polygonal line of property X in the graphs of Figures **11A** and **11B** will be described. First, the time period required until a frame which is to be decoded earliest is decoded is determined and plotted as an x coordinate from the origin 0, and the total bit amount accumulated in the buffer of the decoding device is determined and plotted as a y coordinate located below the origin 0, so as to obtain point **A**. Using point **A** as a starting point, a straight line is drawn upward along the y-axis for a length corresponding to the bit amount of the frame. Then, a straight line is drawn along the x-axis for a length corresponding to the one frame period. Thereafter, a straight line with a length corresponding to the bit amount of a frame which is to be decoded second earliest is drawn along the y-axis, followed by a straight line with a length corresponding to one frame period. This is repeated for all the frames in the buffer in the manner that the frame to be decoded earlier is drawn earlier. For the frame which is currently being encoded, a straight line is drawn based on the bit amount which has been encoded. The end point of this polygonal line is denoted by point **B**.

The polygonal line of property Y will be described. This line is drawn starting from point **B** which indicates the generated bit amount of the frame which is currently being encoded, so that it is always located above property X and above the origin O, and the largest tilt does not exceed the maximum bit rate for the moving image encoding and multiplexing device. Property Y represents the minimum bit amount required to be transmitted to the decoding device within a predetermined time period to avoid underflow in the decoding device. In this example, the time of x-axis is assumed to be the time which elapses from the current time. This minimum transmission bit amount corresponds to the lower limit of the transmission amount obtained at step **502** every calculation period.

The lower limit of the minimum transmission amount in the next calculation period is 0 for property Y in Figure **11A**, while it is L (L>0) for property Y in Figure **11B**.

As described above, in Example 3, a frame of which decoding delay time is shorter is output earlier, and the bit amount required to avoid underflow is preferentially output. Thus, the underflow of the bit amount in the input buffer of the decoding device can be prevented.

(Example 4)

The device of Example 1 described above is effective when the maximum output bit rate and the capacity of the input buffer of the decoding device are not limited. However, when they are limited, underflow may occur in the input buffer of the decoding device since the transmission of the moving image encoded sinal is late. Assume that the bit amount generated in one encoding section suddenly increases because part of an input image is very complicated, for example. In such a case, in the decoding device which decodes the increased bit amount, the bit amount of the frame input into the input buffer becomes larger than the bit amount of the frame read from the input buffer for decoding, resulting in the input buffer being full. Therefore, the bit amount in the corresponding accumulation section located downstream of the encoding section where the bit amount has suddenly increased does not decrease. To compensate this, the bit amounts output from the accumulation sections located downstream of the other encoding sections where the bit amounts have not increased increase, resulting in the decrease in the bit amounts in these accumulation sections. As a result, the available bit amounts in all the accumulation sections decrease, causing the output bit rate at the multiplexing section **3** to become short. Since the quantization control is conducted under the premise that the output bit rate at the multiplexing section **3** is always constant, underflow occurs in the input buffer of the decoding device due to the decrease in the transmission amount. To overcome this problem, it previously required to stuff the signal with bits which do not affect the decoding.

Figure **12** is a block diagram of a moving image encoding and multiplexing device of Example 4 according to the present invention. The device of Example 4 is provided with the following sections additionally to the device of Example 1 shown in Figure 1: that is, a decoder buffer empty capacity calculation section 9 for calculating the bit amount accumulated in the input buffer of the decoding device to determine the empty capacity of the input buffer: a bit amount difference calculation section **10** which calculates the difference between the bit amount in the accumulation section and the buffer empty capacity of the decoding device corresponding to the accumulation section obtained by the decoder buffer empty capacity calculation section **9** for each of the accumulation sections **2-1** to **2-N**: and a stuffing control section **11** which controls a stuffing bit amount generated by each of encoding sections **1-1B** to **1-NB** based on the differential value obtained by the bit amount difference calculation section **10**.

Figure **13** is an exemplified configuration of the encoding sections **1-1B** to **1-NB** in Figure **12**. This configuration is different from that of Figure **2** in that a stuffing sub-section **109-1** is provided downstream of the variable length encoding sub-section **104-1**.

The stuffing sub-section **109-1** inserts stuffing bits of a stuffing amount specified by the stuffing control section **11**

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in the signal output from the variable length encoding sub-section **104-1**, and outputs the resultant signal.

In the device of this example with the above configuration, the decoding delay time calculation section **5** calculates the decoding delay time for the bit of the moving image encoded signal stored in each of the accumulation sections **2-1** to **2-N** which is initially sent to the multiplexing section **3**, as in Example 1, and outputs the results to the decoder buffer empty capacity calculation section **9**. The frame bit amount calculation section **6** calculates the bit amount of a frame including the bit of the moving image encoded signal accumulated in each of the accumulation sections **2-1** to **2-N** which is initially sent to the multiplexing section **3**, as in Example 1, and the outputs the results to the decoder buffer empty capacity calculation section **9**. The bit amounts of the moving image encoded signals accumulated in the accumulation sections **2-1** to **2-N** are summed up by the adder **8**, and the results are output to the decoder buffer empty capacity calculation section **9**.

The decoder buffer empty capacity calculation section **9** is provided with a timer, and holds a moving image output bit rate as a portion of the output bit rate at the multiplexing section **3** allocated for the moving image encoded signal.

More specifically, the decoder buffer empty capacity calculation section **9** calculates the current empty capacity of the input buffer of the decoding device based on the decoding delay time and the bit amount of a frame in the accumulation section and the value indicated by the timer for each of the accumulation sections **2-1** to **2-N**. Thereafter, based on the sum of the bit amounts of the moving image encoded signals accumulated in each of the accumulation sections **2-1** to **2-N** and the output bit rate for the moving image encoded signals output from the multiplexing section **3**, a time T at which all the moving image encoded signals accumulated in each of the accumulation sections **2-1** to **2-N** are transmitted at the output bit rate is calculatedby formula (6) below.

$$T = \frac{\text{Sum of accumulation section bit amounts}}{\text{Moving image output bit rate}} \quad (6)$$

Thereafter, the empty capacity of, the input buffer of the decoding device after the lapse of time T is calculated under the assumption that no moving image encoded signal is input into the input buffer of the decoder from the current time until time T.

The calculation by the decoder buffer empty capacity calculation section **9** will be described with reference to Figures **14A** and **14B**. Figure **14A** shows the current states of the accumulation section and the input buffer of the decoding device, where **A1** denotes the current bit amount in the accumulation section and **B1** denotes the current empty capacity of the input buffer of the decoding device obtained by the decoder buffer empty capacity calculation section **9**. Assume that three frames are decoded by the decoding device during the time from the current time until time T. Then, as shown in Figure **14B**, the decoder buffer empty capacity calculation section **9** outputs a value **B2** corresponding to a total of the value **B1** and the bit amount of the three frames at the head of the input buffer.

The bit amount difference calculation section **10** calculates the difference between the bit amount in the accumulation section and the empty capacitor of the input buffer of the decoding device corresponding to the accumulation section obtained by the decoder buffer empty capacitor calculation section **9** for each of the accumulation sections **2-1** to **2-N**, and outputs the resultant N differential values to the stuffing control section **11**.

Figure 15 is a flowchart showing the operation of the stuffing control section **11**.

First, the N differential values obtained by the bit amount difference calculation section **10** are denoted by G_i (i = 1 to N), and S_p and S_m for calculating the sum of the differential values are set at 0 (step 601). Then, whether or not each of the differential values G_1 to G_N is 0 is examined (step 602). If the differential value is equal to or more than 0, the differential value is added to S_p (step 603). If the differential value is smaller than 0, the absolute value thereof is added to S_m (step 604). Then, whether or not S_p is larger than 0 is examined. If S_p is larger than 0, the process proceeds to steps **605** to 611 where the stuffing bit amount is calculated. If S_p is 0, the process is terminated without stuffing (step **612**). Then, whether or not S_m is larger than S_p is examined (step **605**). If S_m is equal to or larger than S_p, whether or not each of the differential values G_1 to G_N is smaller than 0 is examined (step 606). If yes, the stuffing bit amount for the moving image encoded signal corresponding to the differential value G_1 is calculated by formula (7) below (step **607**). If no, the stuffing bit amount is set at 0 (step **608**).

$$\text{Stuffing bit amount} = Sp \times \frac{|Gi|}{Sm} \quad (7)$$

If S_m is smaller than S_p, whether or not each of the differential values G_1 to G_N is smaller than 0 (step 609). If yes, the stuffing bit amount for the moving image encoded signal corresponding to the differential value G_i is set at the absolute of G_i (step **610**). If no, the stuffing bit amount is set at 0 (step **611**).

After obtaining the stuffing bit amount as described above, the stuffing control section,11 supplies the stuffing bit amount to the stuffing sub-section **109-1** of the encoding section. The stuffing sub-section **109-1** then stuffs the output signal with stuffing bits of the supplied stuffing bit amount.

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Thus, in the device of Example 4 with the stuffing function, when the generated bit amount of part of the moving image encoded signal suddenly increases, the underflow which may occur when no stuffing is conducted is prevented.

The above-described calculation method of the stuffing bit amount is only an example. Other methods may also be employed. For example, the stuffing bit amount may be increased or decreased for byte aligning of the moving image encoded signal and the like. The total stuffing bit amount may be increased or decreased by multiplying S_p by a coefficient. Alternatively, S_p may be equally allocated to the moving image encoded signals where S_m is smaller than 0.

In this example, whether or not the stuffing is conducted was determined by whether or not the value obtained by the bit amount differential calculation section **10** is equal to or more than 0. Any value other than 0 may be used.

(Example 5)

Figure **16** is a block diagram of a moving image encoding and multiplexing device of Example 5 according to the present invention.

The device of this example is the same as that of Example 4 shown in Figure **12**, except that the bit amount difference calculation section **10** outputs the buffer differential value to the quantization control section 4.

The operation of the device of this example with the above configuration will be described. When the conditions for the stuffing is satisfied, the quantization control section **4** outputs a reduced quantization width to the encoding section among the encoding sections **1-1B** to **1-NB** where the stuffing is to be conducted. More specifically, when the quantization width calculated by the quantization control section **4** based on the bit amount output from the adder **8** is Q, a quantization width [k×Q] is supplied to the encoding section where the stuffing is conducted. wherein k is a positive number smaller than 1 and [k×Q] is the maximum integer within the range not exceeding k×Q. The quantization control section **4** receives the buffer differential value from the bit amount difference calculation section **10** and conducts an operation similar to the operation shown in Figure **15**. In this case, however, the quantization width is reduced at steps **607** and **610**, while the quantization width is kept unchanged at steps **608** and **611.**

Thus, in Example 5, the underflow in the decoding device can be prevented by reducing the quantization width used for the encoding to increase the bit amount, instead of the stuffing in Example 4.

(Example 6)

A moving image encoding and multiplexing device of Example 6 according to the present invention will be described. The device of Example 6 is the same as that of Example 5, except that the quantization control section 4 supplies an increased quantization width for the encoding section among the encoding sections **1-1B** to **1-NB** where the conditions for the stuffing are not satisfied. More specifically, when the quantization width calculated by the quantization control section **4** based on the bit amount output from the adder **8** is Q, a quantization width [K×Q] is supplied to the encoding section where the stuffing is not conducted, wherein k is a positive number larger than 1 and [k×Q] is the maximum integer within the range not exceeding k×Q.

The quantization control section **4** receives the buffer differential value from the bit amount difference calculation section 10 and conducts an operation similar to the operation shown in Figure **15**. In this case, however, the quantization width is increased at steps **607** and **610**, while the quantization width is kept unchanged at steps **608** and **611.**

Thus, in Example 6, as opposed to the case of Example 5, the quantization width for the encoding section where the stuffing is not conducted is increased to reduce the bit amount, so as to obtain the same effect as that described in Example 4. The operations of Examples 5 and 6 may be combined so that the quantization width is increased for the encoding section where the bit amount is increased and it is reduced for the other encoding sections.

(Example 7)

Figure **17** is a block diagram of a moving image encoding and multiplexing device of Example 7 according to the present invention. The device of this example is the same as that of Figure **16**, except that the stuffing control section 11 is not provided and that the multiplexing control section **7A** conducts the required control of the stuffing bit amount for the multiplexing section **3**, as well as outputting to the quantization control section **4** the stuffing bit amount which the stuffing control section **11** has instructed the multiplexing section **3** to insert.

In the device of this example with the above configuration, the quantization control section 4 calculates the quantization width based on the bit amounts in the accumulation sections **2-1** to **2-N** added together by the adder 8 and the calculation results by the bit amount difference calculation section **10**. In this example, the quantization control section 4 executes the processings at steps **601** to **604** in Figure **15** to calculate S_P, and adds the resultant S_P to the sum of the bit amounts in the accumulation sections **2-1** to **2-N**. In other words, the sum of the stuffing bit amounts which have been controlled to be inserted at the encoding sections in Example 4 is added to the bit amount of the actually generated moving image encoded signals. Then, the quantization width is. determined as in Example 1. The required stuffing is

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conducted by the multiplexing section **3** under the control of the multiplexing control section **7A**. The stuffing is effected to compensate a short bit amount when the sum of the total multiplex bit amounts is short of the bit amount to be output from the multiplexing section **3** due to the prevention of overflow in the buffer of the decoding device or the shortage of the bit amounts accumulated in the accumulation sections **2-1** to **2-N.**

In this example, the multiplexing control section **7A** performs the stuffing of the required bit amount. The quantization control section **4** predicts the stuffing bit amount and adjusts the quantization size so as to avoid underflow in the decoding device. This generates an error between the predicted stuffing bit amount and the actual bit amount, and thus the predicted amount should be adjusted. In order to adjust the predicted amount, the quantization control section **4** receives the stuffing bit amount from the multiplexing control section **7A** to compare it with S_P. Then, S_P is adjusted so that the error between the accumulated value of S_P and the accumulated value of the stuffing bit amount is within a predetermined range.

Thus, in the device of Example 7, the same effect can be obtained by a simpler configuration compared with the device of Example 4.

(Example 8)

When the number of pixels constituting an input moving image is large, the processing speed by one encoding device may be insufficient. Screen division encoding is one of the methods for encoding a moving image signal representing such a moving image composed of a large number of pixels.

In Examples 1 to 6, the respective encoding sections mainly encode individual moving images. The present invention is also applicable for screen division encoding.

Figure 18 is a block diagram of a moving image encoding and multiplexing device of Example 8 according to the present invention. The device of this example is provided with a screen division section 12 upstream of the encoding sections **1-1A** to **1-NA** of the device of Example 1 shown in Figure **1**. The decoding delay time calculation section **5** in Example 1 is not provided in this example.

The screen division section **12** divides an input moving image into a plurality of segment screens as shown in Figure **19**., and allocates moving image signals representing the respective segment screens to the encoding sections **1-1A** to **1-NA**. The encoding sections **1-1A** to **1-NA** encode the received moving image signals based on the quantization width supplied from the quantization control section **4**. The same quantization width is supplied to the encoding sections 1-1A to **1-NA.** The resultant moving image encoded signals output from the encoding sections **1-1A** to **1-NA** are temporarily accumulated in the accumulation sections **2-1** to **2-N**. The bit amounts in each of the accumulation sections **2-1** to **2-N** are added together by the adder **8**, and the added bit amount is output to the quantization control section **4**. The quantization control section **4** calculates the quantization width based on the bit amount received from the adder **8**.

The frame bit amount calculation section **6** calculates the bit amount of a frame including the bit of the moving image encoded signal accumulated in each of the accumulation sections **2-1** to **2-N** which is initially sent to the multiplexing section **3**. The multiplexing control section **7A** controls the multiplexing section 3 so that the moving image encoded signal of the bit amount calculated by the frame bit amount calculation section 6 is sent from each of the accumulation sections **2-1** to **2-N** to the multiplexing section **3** in the order corresponding to the adopted screen division method. The multiplexing section **3** multiplexes the moving image encoded signal based on the control by the multiplexing control section **7A** so that the encoded signals construct one screen, and outputs the multiplexed signals at a constant bit rate.

Thus, in this example, moving images are encoded with the same quantization width for all the segment screens at the screen division encoding. This suppresses the variation in image quality on one screen.

In this example, one screen was divided into four segments in the horizontal direction. Alternatively, the screen may be divided into segments in the vertical direction or in the combination of horizontal and vertical directions. Also, the number of segments is not limited to four but may be any natural number.

(Example 9)

Figure **20** is a block diagram of a moving image encoding and multiplexing device of Example 9 according to the present invention.

Referring to Figure **20**, the device includes: a moving image switch section **1001** for selecting one from a plurality of input moving image signals and switching the destination of the selected moving image signal: encoding sections **1002-1** to **1002-N** (N is an integer equal to or more than 1) for encoding the input moving image signal; a multiplexing section **1003**; and a control section **1004** for switching the switching state of the moving image switch section **1001**, the encoding method of the encoding sections **1002-1** to **1002-N**, and the multiplexing method of the multiplexing section **1003.**

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In the device with the above configuration, the moving image switch section **1001** receives moving image signals or partial moving image signals representing a plurality of segment screens obtained by dividing one screen of a high-precision moving image. The control section **1004** determines whether or not each of the moving image signals input into the moving image switch section **1001** should be output and, if output, to which encoding section the moving image signal should be output, and controls the moving image switch section **1001** based on the determination. When the partial moving image signals are input, all the partial moving image signals originating from the same moving image signal are selected and output. The control section **1004** determines which signal, the moving image signal or the partial moving image signal, is to be encoded for each of the encoding sections **1002-1** to **1002-N** based on the switching control by the moving image switch section **1001**. The encoding sections **1002-1** to **1002-N** encode the input moving image signals or partial moving image signals and output resultant encoded signals to the multiplexing section **1003**. The control section **1004** controls the multiplexing section **1003** based on the switching control by the moving image switch section **1001**, to multiplex the input moving image signals. In the case of the screen division encoding, the multiplexing section **1003** multiplexes the partial moving image signals originating from the same moving image signal, then multiplexes the resultant multiplexed signals with other plurality of moving image signals, and outputs the resultant signals.

Figure **21** is a block diagram of the multiplexing section **1003** of the device of this example shown in Figure **20**.

Referring to Figure 21, the multiplexing section **1003** includes: a moving image multiplexing sub-section **1021** for multiplexing partial moving image encoded signals obtained by encoding the partial moving image signals; a channel multiplexing sub-section **1022** for multiplexing a plurality of moving image encoded signals; and switches **1023-1** to **1023-N** (N is an integer equal to or more than 1) for switching the destination of the moving image encoded signals input into the multiplexing section **1003**.

The control section 1004 switches the switches **1023-1** to **1023-N** based on the switching control by the moving image switch section **1001**. That is, the switches **1023** which have received the partial moving image signal are switched to the moving image multiplexing sub-section **1021**, while the other switches **1023** are switched to the channel multiplexing sub-section **1022.** The moving image multiplexing sub-section **1021** multiplexes the partial moving image encoded signals obtained by encoding the partial moving image signals originating from the same moving image signal, and outputs the results. The channel multiplexing sub-section **1022** multiplexes the moving image encoded signals output from the moving image multiplexing sub-section **1021** and from the switches **1023**, and outputs the results.

Thus, in this example, a plurality of different moving image signals and a plurality of partial moving image signals generated by dividing one high-precision moving image signal are encoded simultaneously and multiplexed. In the device of this example, the encoding and multiplexing can be conducted even when all the input signals are individual moving image signals or they are partial moving image signals generated by screen division.

In this example, a plurality of moving image signals are individually divided and encoded, and the moving image multiplexing sub-section 1021 multiplexes the partial moving image encoded signals corresponding to one moving image signal for all the moving image signals. Alternatively, a plurality of moving image multiplexing sub-sections may be provided so that each moving image multiplexing sub-section multiplexes one set of partial moving image encoded signals.

(Example 10)

Figure **22** is a block diagram of a moving image encoding and multiplexing device of Example 10 according to the present invention. In the device of Example **10,** the control section **1004** in Example 9 shown in Figure **20** is divided into a switch control section **1041**, an encoding control section **1042,** and a multiplexing control section **1043.**

The switch control section **1041** determines whether or not each of the moving image signals input into the moving image switch section **1001** should be output and, if output, to which encoding section the moving image signal should be output, thereby to control the moving image switch section **1001**. The switch control section **1041** simultaneously outputs a signal representing the switching state to the encoding control section **1042** and the multiplexing control section **1043.**

The encoding control section **1042** determines which signal, the moving image signal or the partial moving image signal, is to be encoded for each of the encoding sections **1002-1** to **1002-N** based on the signal supplied from the switch control section **1041**, as in Example 9. The multiplexing control section **1043** controls the multiplexing section **1003** to multiplex the input moving image signals based on the signal supplied from the switch control section **1041**, as in Example 9.

(Example 11)

Figure **23** is a block diagram of a moving image encoding and multiplexing device of Example 11 according to the present invention.

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In the device of Example 11, a screen division section **1005** is provided upstream of the moving image switch section **1001** shown in Figure **22**. The screen division section **1005** divides an input moving image signal into a plurality of segment screens, to generate partial moving image signals corresponding to the segment screens, and outputs the partial moving image signals to the moving image switch section **1001**. Thus, in this example, a high-precision moving image can be directly input into the moving image encoding and multiplexing device without any previous screen division processing.

Thus, in this example, a plurality of individual moving image signals and a plurality of partial moving image signals generated by dividing one high-precision moving image signal are encoded simultaneously and multiplexed. In the device of this example, the encoding and multiplexing can be conducted even when all the input signals are individual moving image signals or they are partial moving image signals generated by screen division.

In this example, one screen division section is provided. Alternatively, a plurality of screen division sections may be provided in parallel to receive a plurality of moving image signals for screen division simultaneously. Alternatively, instead of providing the screen division section which conducts the screen division for the input moving images, a moving image time division section which divides a moving image signal every several frames and outputs the results to the moving image switch section.

(Example 12)

Figure **24** is a block diagram of a moving image encoding and multiplexing device of Example 12 according to the present invention.

In the device of Example 12, a plurality of accumulation sections **1006-1** to **1006-N**, an adder **1007**, and a frame bit amount calculation section **1008** are additionally provided to the device of Example 11 shown in Figure **23.**

The accumulation sections **1006-1** to **1006-N** accumulate the moving image encoded signals output from the encoding sections **1001-2** to 1002-N. The adder **1007** adds together the bit amounts of the moving image encoded signals accumulated in each of the accumulation sections **1006-1** to **1006-N.** The frame bit amount calculation section **1008** calculates the bit amount of each frame of the moving image encoded signals accumulated in the accumulation sections **1006-1** to **1006-N.**

In the device with the above configuration, the moving image encoded signals output from the encoding sections **1002-1** to **1002-N** are temporarily accumulated in the accumulation sections **1006-1** to **1006-N**. The bit amounts of the moving image encoded signals in each of the accumulation sections **1006-1** to **1006-N** are added together up by the adder **1007,** and the added bit amount is output to the encoding control section **1042**. The encoding control section **1042** calculates the quantization width based on the bit amount received from the adder **1007**.

In this example, the quantization width is set larger as the bit amount is larger, and smaller as the bit amount is smaller, in accordance with the constant output bit rate at the multiplexing section **1003.** The encoding control section **1042** outputs one quantization width obtained in this way to each of the encoding sections **1002-1** to **1002-N.** The encoding sections **1002-1** to **1002-N** encode the received moving image signals based on the quantization width.

Thus, in this example, the input signals can be encoded in accordance with the output bit rate at the multiplexing section **1003** though the output bit rate is constant. Moreover, since the same quantization width is used for the compression/encoding of input moving images with different precisions, the quality of the plurality of output moving images can be always made uniform. Furthermore, since the quantization control is conducted based on the sum of the bit amounts of the moving image encoded signals accumulated in each of the accumulation sections **1006-1** to **1006-N**, the output bit rate can be effectively used.

In this example, the quantization width is set for the encoding sections **1002-1** to **1002-N**. Alternatively, other values such as the bit rate may be set.

Thus, in this example, a plurality of partial moving image signals generated by dividing one moving image by screen division can be encoded simultaneously and multiplexed.

In Examples 9 to 12, one moving image switch section is provided upstream of the encoding sections. Alternatively, two or more moving image switch sections may be provided in parallel. Also, in these examples, only moving image signals are encoded and multiplexed. Alternatively, the device may be configured so that other signals such as sound signals are also multiplexed.

(Example 13)

An image transmission device of Example 13 according to the present invention will be described with reference to Figures **25** to **27**.

Figure **25** is a block diagram of an image transmission device of Example 13. Referring to Figure **25,** the image transmission device includes image encoding sections **2001, 2002, 2003**, ... and a multiplexing section 2010. The image encoding sections **2001, 2002, 2003,** ... include encoding sub-sections **2004, 2005, 2006**, ... and intermediate

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buffers **2007, 2008, 2009**, ... respectively. The multiplexing section 2010 includes an input/output control subsection **2010a** and an output buffer **2010b**.

The operation of the device with the above configuration will be described.

The image encoding sections **2001, 2002, 2003**,... compress/encode respective input image signals. The encoding sub-sections **2004, 2005, 2006**, ... of the image encoding sections **2001, 2002, 2003**, ... employ MPEG2 encoding, i. e., encode the input image signals into image signals conforming to the ISO/IEC 13818-2 (generally called MPEG2 video) MP@ML, and, every predetermined constant multiplexing period, output an amount of encoded data which is desired to be multiplexed in the next multiplexing period to the respective intermediate buffers **2007, 2008, 2009**, ... The multiplexing section **2010** receives and takes all the encoded data accumulated in the intermediate buffers **2007, 2008, 2009**, ... of the image encoding section **2001, 2002, 2003**, ... in the output buffer **2010b** every multiplexing period based on the control of the input/output control sub-section **2010a**. Then, in accordance with the order of the taking-in of the encoded data, the encoded data is sequentially output to a transmission route at a transmission rate of the transmission route. The order of the taking-in of the encoded data from the intermediate buffers of the image encoding sections is not limited as far as the encoded data can be taken in the output buffer within the taking-in period. Thereafter, the multiplexing section **2010** determines a buffer occupation Bmux_oc of the encoded data in the output buffer **2010b** at the completion of the taking-in, and outputs the results to the image encoding sections **2001, 2002, 2003**, ... By calculating Bmux_oc/R wherein R denotes the transmission rate at the transmission route, the encoding sub-sections **2004, 2005, 2006,** ... can relatively estimate the transmission delay time of each encoded data when the encoded data is output from the multiplexing section **2010**. The image encoding sections **2001, 2002, 2003**, ... encode the input images using the estimated value.

The image encoding sections **2001, 2002, 2003,** ... compress/encode the input image signals into MPEG2 video data. In the MPEG2 encoding, inter-frame prediction encoding is conducted for the image signals, and a prediction error component generated by the prediction encoding is encoded by DCT. The bit amount of the encoded data is determined by increasing or decreasing the quantization width used at the quantization of a DCT coefficient. When the quantization width is small, the generated bit amount is large, but the image is compressed and encoded to obtain an image closer to the original image. On the contrary, when the quantization width is large, the generated bit amount is small, but the resultant image is degraded due to a distortion caused by a quantization error. Accordingly, in order to encode the image signals so as to obtain an image with a uniform quality closer to the original image, the quantization width needs to be controlled so as to be as small as possible, as constant as possible, and have a variation as small as possible. In this example, the image quality and the generated bit amount is controlled based on the quantization width. The operation of the encoding sections other than the control with the quantization width is based on known techniques (see "Latest MPEG Textbook", Ascii Publishing, 1995, pp. 103-105, for example). Hereinbelow, therefore, the control of the quantization width will be described in detail.

Figure **26** shows a configuration of the encoding sub-section of the image encoding section. Referring to Figure **26**, the encoding sub-section includes a basic encoding portion **2011**, a bit counter **2012**, a buffer **2013** for temporarily storing encoded data, and a control portion **2014**. The basic encoding portion **2011** includes a difference processor **2011a,** a DCT processor **2011b**, a quantization processor **2011c,** a variable length encoder **2011d**, and an inter-frame predictor **2011e.**

The basic encoding portion **2011** encodes an image signal into the MPEG2 video format. More specifically, the inter-frame predictor **2011e** determines a prediction value, the difference processor **2011a** calculates a prediction error of the prediction value, the DCT processor **2011b** processes the prediction error by DCT, the quantization processor **2011c** quantizes the DCT-processed value, and the variable length encoder **2011d** encodes the quantized value. The quantization processor **2011c** receives a quantization width from the control portion **2014.** The input image signal is quantized and encoded in accordance with the quantization width. The resultant encoded data is transmitted to the buffer **2013.** The bit counter **2012** counts the bit amount of the encoded data, and the generated bit amount is sent to the control portion **2014** every multiplexing period. The control portion **2014** determines the quantization width based on the buffer occupation Bmux_oc in the output buffer **2010b** sent from the multiplexing section **2010** and the generated bit amount sent from the bit counter **2012**, and supplies the quantization width to the basic encoding portion **2011**. The control portion **2014** also calculates the bit amount to be sent to the corresponding intermediate buffer of the image encoding section, and supplies the bit amount to the buffer **2013**. The buffer **2013** outputs the encoded data sent from the basic encoding portion **2011** to the corresponding intermediate buffer in accordance with the bit amount specified by the control portion **2014.**

Figure **27** is a flowchart showing the calculation of the quantization width by the control portion **2014** of the encoding sub-section. Referring to Figure **27**, the process is started at step **2201**. A reference quantization width q st, an encoding sub-section buffer occupation Bei_oc, an intermediate buffer occupation Bmi oc, and a parameter Di are initialized at step **2202.** Whether or not the encoding is completed is examined at step **2203.** If yes, the process is terminated at step **2204**. If no, the quantization width is calculated at step **2205**. The generated bit amount is detected at step **2206**. The bit amount to be output is calculated at step **2207**. The output buffer occupation Bmux_oc is received at step **2208**,

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and the parameter Di is calculated at step **2209**. Then, the processing for preventing the underflow in the output buffer (step **2210**) and the encoding skipping (step **2211**) are conducted.

The above operation is conducted for all the encoding sub-sections shown in Figure **25**. Hereinbelow, the operation of the i-th encoding sub-section as an example will be described in detail.

After the initialization (step **2202**), the control portion **2104** calculates the quantization width every multiplexing period by setting the buffer size of a presumed decoding device on the receiver side which is to reproduce data encoded by the i-th encoding sub-section as Bdec_size by formula (8) below (step **2205**) until the encoding is completed (step **2203**).

$$qi = (Bdec_size/(Bdec_size-Di))\cdot q_st \tag{8}$$

wherein q_st denotes the reference quantization width which is preset at the initialization so that a desired image quality can be obtained. Di denotes the variable which varies every multiplexing period. The calculation of this variable will be described. The encoding sub-section outputs encoded data to the intermediate buffer in the image encoding section every multiplexing period. More specifically, the control portion **2014** detects the bit amount generated during the multiplexing period from the bit counter **2012**. When the sum of the generated bit amount and a non-output remaining bit amount REMi is smaller than the size of the intermediate buffer, the control portion **2014** sends to the buffer **2013** an instruction output amount Bmi which indicates that all the encoded data (i.e., the sum of REMi and the generated bit amount) should be output to the intermediate buffer within the range not exceeding an upper limit specified in a standard (e.g., 15 Mbps under MP@ML). When the sum is larger than the size of the intermediate buffer, the control portion **2014** sends to the buffer **2013** an instruction output amount Bmi which indicates that an amount equal to the capacity of the intermediate buffer should be output while holding the remainder in the buffer **2013** as non-output remaining data (steps **2206** and **2207**).

Then, when the amount of the encoded data which has been encoded by the encoding sub-section but has not been reproduced is larger than the buffer size Bdec_size of the decoding device after the encoded data has been multiplexed at a multiplexing period capable of calculating from the output buffer occupation Bmux_oc and arrived at the receiver side, the instruction output amount Bmi is determined so that the value obtained by subtracting the buffer size Bdec_size from the non-reproduced encoded data amount is equal to the remaining non-output data bit amount REMi. In other words, the buffer of the decoding device is prevented from overflowing by keeping the amount of data which arrives at the receiver side equal to the buffer size Bdec_size. More specifically, the upper limit of the encoded data amount is set at a value obtained by subtracting the buffer occupation from the buffer size of the decoding device. The non-reproduced encoded data amount mentioned above is determined as follows, for example.. In the case where the reproduction time is specified to the decoding device by a time stamp added to the encoded data so that the encoded data is reproduced by the decoding device at a delay time of 0 when the buffer occupation Bmux_oc in the output buffer **2010b** becomes equal to the buffer size Bmux_size, bit amounts bT generated in the respective encoding sub-sections during the time (Bmux_size-Bmux_oc)/R are calculated and summed up.) Then, the bit amount of the non-output data is calculated by formula (9) below:

$$REMi = REMi + bT - Bmi \tag{9}$$

wherein bT is the bit amount generated during one multiplexing period.

Thereafter, the control portion **2104** receives the current data occupation Bmux_oc of the output buffer **2010b** of the multiplexing section **2010**, and calculates the parameter Di by formula (10) below under the premise of formula (11) below (steps **2208** and **2209**).

$$Di = Bdec_size * Bmux_oc/Bmux_size + f(REMi) \tag{10}$$

$$f(REMi) = REMi \tag{11}$$

The quantization width is calculated from the thus-obtained parameter Di by formula (8).

In order to prevent the value obtained by subtracting the parameter Di from the decoder buffer size (Bdec_size - Di) from becoming 0, the control portion **2014** instructs the basic encoding portion **2011** to conduct skipping when (Bdec_size - Di) is equal to or less than a threshold K. The basic encoding portion **2011** then skips the encoding of the image signal (steps **2210** and **2211**).

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The multiplexing section **2010** takes in the encoded data stored in the intermediate buffer of each of the image encoding sections every multiplexing period, multiplexes the encoded data into a packet in accordance with the ISO/IEC 13818-1 (normally called the MPEG2 TS stream), and outputs the packet to the transmission route. At this time, the reproduction time indicated by the time stamp for specifying the reproduction timing of each image to the encoding device is determined based on the buffer occupation Bmux_oc of the output buffer **2010b.** That is, the reproduction of the encoded data should be started at a delay time of 0 when the output buffer **2010b** has become full. Using this timing as the reference, the reproduction time is determined and the time stamp indicating this reproduction time is added to each packet to be transmitted.

With the above configuration, the initial transmission start time at the multiplexing section 2010, the output buffer size Bmux_size of the multiplexing section **2010**, and the like should actually be changed depending on the number of image encoding sections N connected with the multiplexing section **2010,** the transmission rate, and the like. In this example, however, when Bmux_size = N×Bdec_size is set, it is assumed that the encoded data immediately after encoding is multiplexed and arrives at the decoding device when the output buffer occupation Bmux_oc is 0 and that this encoded data is reproduced after X pictures (i.e., there is a possibility that data corresponding to X pictures at maximum is accumulated in the decoding device). Using the case of the output buffer occupation Bmux_oc being 0 as the reference, the relative delay time of the encoded data which is multiplexed when the output buffer occupation Bmux_oc is an arbitrary value is calculated as Bmux_oc/R. Accordingly, the data amount of pictures held in the decoding device when the data arrives at the decoding device is x·(Bmux_size-Bmux_oc(t))/Bmux_size (when the non-output data amount is 0). In such a case, the encoded data is received by the receiver side without underflowing.

More specifically, first, when REMi=0, formula (12) below is obtained from formulae (8) and (9).

$$qi = (Bmux_size/(Bmux_size - Bmux_oc))\cdot q_st \tag{12}$$

As is apparent from formula (12), the quantization width is larger as the output buffer occupation Bmux_oc is closer to the output buffer size Bmux_size. Thus, the generated bit amount is suppressed to prevent underflow from occurring. Even if an extremely complicated image is input, Bmux_oc is always controlled to be smaller than Bmux_size by the skipping at step **2211** in Figure **27**. This also prevents underflow from occurring.

When REMi≠0, formula (13) below is obtained.

$$qi = q_st/(1 - (Bmux_oc/Bmux_size) - REMi/Bdec_size) \tag{13}$$

As is apparent from formula (13), the image encoding section is controlled so that REMi is smaller than Bdec_size× (Bmux_size-Bmux_oc)/Bmux_size. Even if an extremely complicated image is input, the image encoding section is controlled so that REMi is smaller than Bdec_size×(Bmux_size-Bmux_oc)/Bmux_size by reducing the generated bit amount by the skipping at step **2211** in Figure **27**. Even if all the other image encoding sections request to multiplex their encoded data of the maximum bit amount, the encoded data can be at least multiplexed at an average rate obtained by dividing the transmission rate by the number of image encoding sections. Since Bdec_size×(Bmux_size-Bmux_oc)/Bmux_size corresponds to the bit amount of the encoded data which can be transmitted at the average rate within the time (Bmux_size-Bmux_oc)/R, no underflow occurs on the receiver side.

Since the encoded data exceeding the buffer capacity of the decoding device is left as non-output data, no overflow occurs and thus all the encoded data which have been encoded by the image encoding sections are remained reproducible.

With the above configuration, the image encoding sections determine the quantization width in accordance with the same reference. Accordingly, when no non-output data is left, the quantization widths used in all the image encoding sections are the same irrespective of the input images, and thus the input images can be encoded so as to render substantially the same image quality. Even when a scene change is included in a series of input images, since the quantization width is controlled in accordance with the generated bit amount in all the image encoding sections, bits are allocated depending on the increase in the complexity without extremely degrading the image quality at the point of the scene change, while the influence of the bit increase and the change in the image quality are kept small. Each of the image encoding sections controls the generated bit amount and the bit amount of the encoded data to be multiplexed so that the encoded data does not overflow or underflow on the receiver side. Accordingly, the multiplexing section 2010 only serves to multiplex the received encoded data regularly, not being required to process information on the entire images as conventionally required. Thus, since the processings are dispersed, the device can be easily configured.

In this example, the quantization width is calculated by formula (8). Another formula may be used as far as Bdec_size-Di > 0 is maintained.

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Another function may be used for f(REMi)=REMi of formula (11). Alternatively, the decision characteristics for determining the quantization width for a specific image encoding section and f(REMi) may be changed intentionally so as to keep high the image quality of a specific image signal. For example, when the capacity of the intermediate buffer of the j-th encoding section is made M times as large as that of the other intermediate buffers, f(REMi) may be made REMi/M. By doing this, the amount of the non-output encoded data can be increased to an amount closer to M times of REMi which is allowable in this example. Normally, when an image more complicated than the average of all images is being input, the size of data corresponding to x·(Bmux_size-Bmux_oc(t))/Bmux_size pictures which have been encoded when the encoded data multiplexed at the time of Bmux oc arrives at the decoding device is limited to Bdec_size+REMi. Thus, having more non-output data makes it possible to allocate relatively more bits for a complicated image of which encoding is difficult.

In this example, as the multiplexing period is shorter, the control is more precise. However, several macro-blocks or several slices (several lines of image signals) of MPEG2 data are appropriate for the multiplexing period. A long period of one picture and the like may also be used.

In this example, the encoding method and the data transmission method are the same for all the image encoding sections. Alternatively, a specific basic encoding portion may be processed under an image quality control different from the standard one. For example, any value may be used as the decision function for the quantization width in Formula (8) as far as the function increases the quantization width with the increase in Di. The image quality may be made uniform by reducing the change rate of the quantization width. Alternatively, while almost all the image encoding sections are operated as described above, in a specific image encoding section, the quantization width may be fixed to make the image quality uniform, or the data may be encoded at a fixed rate in the image encoding section to generate bits. In such a case, the generated bit amount tends to decrease with the increase in Di as a whole. Thus, the entire bit rate can be within the bit rate at the transmission route.

(Example 14)

An image transmission device of Example 14 according to the present invention will be described with reference to Figures **28** to **34.**

Figure **28** schematically shows the image transmission device of Example 14. Referring to Figure **28**, the image transmission device includes a bit rate management node **2015** for controlling the bit rate on a LAN (local area network), and nodes **2016** to **2019** connected to the LAN which have image encoding sections. Each of the nodes **2016** to **2019** includes an image reproduction section as well as the image encoding section. The image encoding section encodes images in consideration of the buffer size Bdec_size and the buffer occupation of a decoding device of the image reproduction section of a destination node.

With the above configuration, one of the image encoding sections which are disposed in the nodes connected with one another via the LAN transmits encoded data to another image encoding section on the LAN as a packet. The packet is composed of header information required for the transmission and the encoded data.

Figure **29** shows a header format. The header information includes information required for correct transmission of the encoded data, i.e., presumably known information required on the LAN. In this example, the description on such information is omitted, and only a sender address, a receiver address, an image packet flag, and a transmission period number are described. In the network, a one-way transmission route extends between every adjacent nodes, forming a ring. The bit rate management node **2015** controls the generation of packets. That is, the bit rate management node **2015** secures the bit rate in response to the requests from the nodes and generates the packets for transmission.

Figure **30** is a view for describing the communication method between the nodes. In the communication between the nodes **2016** and **2019**, for example, the bit rate management node **2015** generates a packet having the sender address of 1 and the receiver address of **4**, and outputs the packet onto the network at a vacant packet timing. Each node passes a packet which is not related to itself to the adjacent node as it is. On receipt of the packet having the sender address of 1, the node **2016** puts the encoded data which the node **2016** desires to transmit in the packet and transmits the packet to the next node **2017**. the nodes **2017** and **2018** pass this packet to the next node as it is. The node **2019** detects its own address, i.e., address **4**, as the receiver address in the packet, receives the encoded data in the packet, and then release the packet.

Hereinbelow, the transmission of encoded data representing images will be described with reference to Figures **31** to **36**.

The bit rate management node **2015** secures the entire bit rate for the encoded data to be transmitted in the network. For example, assume that the number of nodes which transmit encoded data in the network is four and the average bit rate for each node is about 3 Mbps. In such a case, the bit rate management node **2015** secures a 12 Mbps bit rate and outputs packets for image transmission corresponding to 12 Mbps. Each of the respective packets for image transmission is provided with a multiplexing period number which is renewed every multiplexing period. Each node identifies the multiplexing period number of each received packet and outputs the packet during the multiplexing

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period indicated by the multiplexing period number. Prior to the output of the packet, each node notifies of the number of packets to be output during each multiplexing period.

Figure **31** is an example of the transmission of the packet for notification of the number of packets. In this packet, both the sender and receiver addresses are ff and the image packet flag is 1 so that each node identifies that this is the packet for notification of the number of packets. On receipt of such a packet, each node enters the number of packets to be transmitted by the node during the multiplexing period corresponding to the indicated multiplexing period number. The bit rate management node **2015** reads the packet for notification of the number of packets which has been circulated through the network, and outputs the packets for image transmission having the same multiplexing period number by the number equal to the total number of packets notified.

Figure **32** is an example of the transmission of encoded data using the packet for image transmission. The bit rate management code **2015** generates a packet for image transmission having the image packet flag of 1 and a certain multiplexing period number, and outputs the packet on the network. This packet is available for any node which has notified of image transmission. Therefore, any node which desires to transmit its encoded data during the indicated multiplexing period writes its own address and the receiver address on the header of the packet, puts the encoded data in the packet, and transmits the packet to the destination node. In the example shown in Figure **32,** the transmission from the node **2016** to the node **2019** is shown. The node **2019** receives this packet, resets the data in the packet, and outputs the packet on the network. After the node **2016** located closest to the bit rate management node **2015** has transmitted all the packets which the node **2016** intended to transmit during the indicated multiplexing period, the node **2016** passes subsequent packets having the same multiplexing period number to the next node as it is. The node **2017** located second closest to the bit rate management node **2015** puts its encoded data to be transmitted during the indicated multiplexing period in the packet and transmits the packet, as described above for the node **2015.**

In this way, each of the respective nodes receives the number of packets equal to the number of packets notified by the node, put -its encoded data to be transmitted during the indicated multiplexing period in the packets, and outputs the packets on the network in such a manner that the nodes closer to the bit rate management node **2015** conduct this operation earlier. Since the bit rate management node **2015** generates the number of packets having the same multiplexing period equal to the total number of packets notified by the nodes, the packets are neither short nor excessive. Thereafter, packets for the next multiplexing period are generated in accordance with the notifications by the nodes.

The multiplexing period used in this example corresponds to the multiplexing period described in Example 11, and is actually determined by calculating the delay time taken until the bit rate management node 2015 generates packets having the multiplexing period number based on the total number of packets notified.

For example, assuming that the multiplexing period is T and the delay data amount after T×k is DD(kT), the delay data amount after T×(k+1), i.e., DD((k+1)T), is calculated by formula (14) below.

$$DD((k + t)T) = DD(kT) + Pn \cdot P_DATA - RT \quad (14)$$

wherein Pn denotes the total number of packets which had been notified at that time, P_DATA denotes the data amount per packet, and R is the bit rate for image transmission secured by the bit rate management node **2015**.

Then, the virtual output buffer size of all the encoding sections (hereinbelow, referred to as the multiplex virtual buffer size), Bmux_size, is calculated based on formula (15) below, and the relative delay parameter delay_mux is calculated based on formula (16) below. The resultant multiplex virtual buffer size and the relative delay parameter are put in the packet for image transmission in accordance with the format shown in Figure 29.

$$Bmux_size = N \times Bdec_size \quad (15)$$

$$delay_mux = Bmux_size - (delay_init \times R) + DD \quad (16)$$

wherein delay_init denotes the delay time from the arrival of the data transmitted when the delay data amount DD is 0 until the reproduction of the data, which is shared by the nodes in the network. The calculated values are put in the header of the packet generated immediately after the calculation, and transmitted.

Figure 33 shows the transmission of the packets generated by the bit rate management node **2015.**

The packets for notification of the number of packets are generated every predetermined period. The packets for image transmission are generated by the number notified in the packet for notification of the number of packets, based on the rate R secured by the bit rate management node **2015** for the transmission of all the encoded data representing images. However, in the case where the delay data amount DD increases to be equal to delay_init×R during one multiplexing period, the generation of the packets in this multiplexing period is terminated and the multiplexing period

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number is renewed even if the number of generated packets is short of the number of packets notified. In the case where the generation of packets of the notified number is complete within one multiplexing period, packets having the renewed multiplexing period number are generated in the next multiplexing period. Thus, the encoded data of the number of packets notified by the nodes are transmitted so that the multiplex delay amount DD does not exceed delay_init×R.

Figure **34** shows a configuration of each node. Referring to Figure **34**, the node includes a packet processing section **2020** for processing input/output of packets, a control section **2021**, an intermediate buffer **2022**, and an encoding section **2023**, and an image reproduction section **2024**.

The packet processing section **2020** receives a packet transmitted via the network and detects the header of the packet. When the receiver address of the header is its own address, the packet processing section **2020** passes the contents of the packet to the control section 2021 and simultaneously outputs the packet after resetting the sender address and the receiver address of the packet. When the transmitted data in the packet is encoded data representing images, the control section **2021** passes the encoded data to the image reproduction section **2024** for reproduction of the images.

When the sender address of the received packet is its own address, the packet processing section **2020** rewrites the encoded data in the packet based on information from the control section **2021** or the intermediate buffer **2022**, and outputs the resultant packet.

When the header information indicates that the packet is for notification of the number of packets, the packet processing section **2020** sends to the control section **2021** a detection signal indicating that the packet is for notification of the number of packets. together with the multiplexing period number in the packet. The control section **2021** sends the number of packets to be notified for the indicated multiplexing period to the packet processing section **2020.** The number of packets to be notified for this multiplexing period corresponds to the data amount to be sent from the encoding section **2023** to the intermediate buffer **2022** during the indicated multiplexing period. This data amount is counted by the intermediate buffer **2022**, and the counted value is determined as the value to be notified by the control section **2021**. The packet processing section **2020** writes the value to be notified in the packet and outputs the resultant packet onto the network.

When the header information of the packet indicates that the packet is for image transmission, the packet processing section **2020** sends a detection signal indicating that the packet is for image transmission to the control section **2021**. The control section **2021** then reads the multiplexing period number of the packet. If the number of packets already output during the indicated multiplexing period is short of the number of packets notified, the control section **2021** instructs the packet processing section **2020** to write encoded data representing images together with the receiver address. The packet processing section **2020** writes its own address as the sender address and the specified receiver address as the destination address, reads encoded data corresponding to one packet from the intermediate buffer **2022,** writes the encoded data in the packet, and outputs the resultant packet onto the network. After the notified number of packets have been output during this multiplexing period, the control section **2021** renews the multiplexing period number. The control section **2021** also sends an output instruction signal to the packet processing section **2020** to allow a subsequent packet having the old multiplexing period number before the renewal to be output without any processing.

On receipt of the packet for image transmission, also, the control section **2021** receives the multiplex virtual buffer size Bmux_size and the relative delay parameter delay_mux of the packet from the packet processing section **2020,** and passes these values to the encoding section **2023.** These values are always detected irrespective of the transmission timing.

Hereinbelow, the operation of the encoding section **2023** will be described. The operation of the encoding section **2023** is substantially the same as that of the encoding sub-section in Example 13 shown in Figure **26.**

In this example, the control portion **2014** shown in Figure **26** receives the multiplex virtual buffer size Bmux_size and the relative delay parameter delay_mux from the control section **2021** in Figure **34,** and conducts the same processing as that described in Example 13. using these values instead of the buffer size Bmux_size and the buffer occupation Bmux oc of the multiplexing section **2010** in Example 13 (see Figure **25**). In this example, since the transmission rate R set by the bit rate management node **2015** is equivalent to the transmission rate at the multiplexing section **2010** in Example 13, the encoded data to be transmitted and received between the encoding sections of the nodes is transmitted at a timing at which the encoded data can be reproduced without overflow or underflow on the receiver side.

Thus, according to this example, images can be transmitted on a network keeping the image quality substantially uniform. Figures **35A** and **35B** show the comparison between the conventional transmission of encoded data on a network with a variable bit rate and the transmission of encoded data in this example in the aspect of the utilization of the bit rate. In the conventional case, the transmission bit rate for the encoded data encoded depending on the complexity of the image is secured on the transmission route. In this case, as shown in Figure **35A**, when three pieces of encoded data are to be transmitted, for example, all the bit rate at the transmission route fails to be effectively used. In this example, however, as shown in Figure **35B**, since all the bit rate at the transmission route is always used for

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encoding, the bit rate can be effectively used. Since data is encoded using a large bit amount, high-quality images can be reproduced. When the image quality is not made high, more images can be transmitted on the network.

In this example, the network connecting the nodes in a ring was described. The present invention is also applicable to a network of another shape or a network with a different transmission protocol as far as the bit rate allocated for an image on the transmission route is secured, the delay amount at the transmission is supplied to each node, and encoded data generated by the encoding section can be transmitted.

The delay time denoted by delay_init may be arbitrarily set within the range of Bmux_size-(delay_init×R)≥0. Especially, when Bmux_size-(delay_init=R)=0 is satisfied, the most effective variable length encoding is possible. As in Example 13, only a specific image can be encoded to obtain high quality by changing the setting of a specific encoding section. Moreover, in this example, at least the average rate obtained by dividing the entire bit rate by the number of entries can be secured every multiplexing period by multiplexing the allowable maximum data amount. Accordingly, it is possible to transmit the image signal encoded at an average rate.

In this example, the case where the number of images which are being transmitted is not changed was described. Alternatively, the number of images may be changed during the transmission. In such a case, Bmux size and delay_mux should be renewed. In the case where the relative delay parameter delay_mux becomes negative due to the change in the number of images during the transmission, delay_mux should be renewed to a value smaller than the value obtained based on formula (16) before the addition of a new image, to reduce delay_mux to such an extent that delay_mux will not become negative by the addition of a new image.

As shown in Figure 36. the nodes in this example may be implemented by general computers by incorporating the algorithm described in this example as a software. This invention is applicable to the encoding of image signals obtained from a camera or image signals in a memory such as a hard disk of a general computer.

Various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be broadly construed.

Claims

1. A moving image encoding device for encoding a plurality of moving image signals, comprising:

   a plurality of encoding sections for encoding the plurality of moving image signals, the encoding sections being provided with a plurality of quantization sub-sections for quantizing the plurality of moving image signals with predetermined quantization widths; and
   a quantization control section for controlling the quantization widths used by the quantization sub-sections simultaneously.

2. A moving image encoding device according to claim 1. wherein the quantization widths used by the quantization sub-sections are the same.

3. A moving image encoding device according to claim 1, further comprising a plurality of accumulation sections for temporarily accumulating a plurality of moving image encoded signals output from the plurality of encoding sections.
   wherein the quantization control section determines the quantization widths used by the quantization sub-sections based on a sum of bit amounts of the plurality of moving image encoded signals accumulated in the accumulation sections.

4. A moving image encoding device according to claim 1, further comprising a screen division section disposed upstream of the plurality of encoding sections for dividing an input moving image signal into a plurality of moving image signals.

5. A moving image multiplexing device for multiplexing a plurality of moving image encoded signals obtained by encoding a plurality of moving image signals, comprising:

   a plurality of accumulation sections for temporarily accumulating the plurality of moving image encoded signals;
   a multiplexing section for multiplexing the plurality of moving image encoded signals accumulated in the plurality of accumulation sections and outputting the multiplexed signals at a constant bit rate;
   a decoding delay time calculation section for calculating a time period from when a specific bit of each of the plurality of moving image encoded signals is input into a decoding device until when the specific bit is decoded by the decoding device;

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a frame bit amount calculation section for calculating a bit amount of a frame including the specific bit of each of the plurality of moving image encoded signals accumulated in the plurality of accumulation sections; and
a multiplexing control section for controlling a plurality of first input bit amount which are the bit amounts of the plurality of moving image encoded signals input from the plurality of accumulation sections to the multiplexing section based on calculation results of the decoding delay time calculation section and the frame bit amount calculation section.

6. A moving image multiplexing device according to claim 5, wherein the multiplexing control section comprises:

a first parameter generation sub-section for determining a plurality of first parameters each of which is a ratio of the bit amount calculated by the frame bit amount calculation section to the time calculated by the decoding delay time calculation section;
a second parameter generation sub-section for determining a second parameter which is a sum of the plurality of first parameters;
a third parameter generation sub-section for determining a plurality of third parameters each of which is a ratio of each of the plurality of first parameters to the second parameter for the plurality of moving image encoded signals accumulated in the plurality of accumulation sections; and
a multiplex bit amount calculation section for calculating the plurality of first input bit amounts based on the plurality of third parameters.

7. A moving image multiplexing device according to claim 6, further comprising:

an accumulated bit amount calculation section for calculating the bit amounts of the plurality of moving image encoded signals accumulated in the plurality of accumulation sections; and
an empty capacity calculation section for calculating an empty capacity of an input buffer of a decoding device immediately before a specific bit of each of the plurality of moving image encoded signals is input into the decoding device.
wherein the multiplex bit amount calculation section sets for each of a plurality of second input bit amounts a minimum value among

(1) the first input bit amount determined based on the third parameter,
(2) the bit amount of the moving image encoded signal calculated by the accumulated bit amount calculation section, and
(3) the empty capacity of the input buffer of the decoding device calculated by the empty capacity calculation section, and

the multiplex bit amount calculation section controls the bit amounts of the moving image encoded signals sent from the accumulation sections to the multiplexing section based on the plurality of second input bit amounts.

8. A moving image multiplexing device according to claim 7, wherein, when the plurality of second input bit amounts calculated by the multiplex bit amount calculation section are different from the corresponding first input bit amounts, the multiplex bit amount calculation section increases the second input bit amounts.

9. A moving image encoding method for encoding a plurality of moving image signals simultaneously, comprising encoding all the plurality of moving image signals with a same quantization width.

10. A moving image encoding method for encoding a plurality of moving image signals simultaneously, comprising encoding the plurality of moving image signals with a quantization width obtained based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and output bit amounts of the plurality of moving image encoded signals output after being temporarily accumulated.

11. A moving image multiplexing method for multiplexing a plurality of moving image encoded signals after being accumulated in a plurality of accumulation sections, comprising the steps of:

(1) calculating a time period from when a specific bit of each of the plurality of moving image encoded signals is input into a decoding device having an input buffer until when the specific bit is decoded;

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(2) calculating a bit amount of a frame including the specific bit of each of the plurality of moving image encoded signals accumulated in the plurality of accumulation sections: and
(3) determining a plurality of multiplex bit amounts to be multiplexed from the plurality of moving image coded signals based on calculation results from steps (1) and (2).

12. A moving image multiplexing method according to claim 11, wherein step (3) comprises the steps of:

(4) determining a plurality of first parameters each of which is a ratio of the bit amount obtained in step (2) to the time obtained in step (1);
(5) determining a second parameter which is a sum of the plurality of first parameters;
(6) determining a plurality of third parameters each of which is a ratio of each of the plurality of first parameters to the second parameter for the plurality of moving image encoded signals; and
(7) determining the plurality of multiplex bit amounts based on the plurality of third parameters.

13. A moving image multiplexing method according to claim 12, wherein an input multiplex bit amount used for multiplexing each of the plurality of moving image encoded signals is set at a minimum value among

(1) the multiplex bit amount determined based on the third parameter,
(2) the bit amount of the moving image encoded signal accumulated in the accumulation section. and
(3) an empty capacity of the input buffer of the decoding device, and

each of the bit amounts to be multiplexed is controlled using the input multiplex bit amount.

14. A moving image multiplexing method according to claim 13, wherein, when at least one of the input multiplex bit amounts is different from the corresponding multiplex bit amount, the input multiplex bit amount is increased.

15. A moving image multiplexing method for multiplexing a plurality of moving image encoded signals, a plurality of multiplex bit amounts corresponding to the plurality of moving image encoded signals being preset at zero, the method comprising the steps of:

(1) calculating a frame bit amount of a frame including a specific bit of each of the plurality of moving image encoded signals:
(2) calculating a time period until each of the plurality of moving image encoded signals is decoded;
(3) selecting the moving image encoded signal where the time period obtained in step (2) is shorter than a predetermined time value,
(4) determining a plurality of primary multiplex bit amounts based on the frame bit amount of the moving image encoded signal selected in step (3);
(5) calculating a sum of the plurality of primary multiplex bit amounts;
(6) adding the plurality of primary multiplex bit amounts to the plurality of multiplex bit amounts: and
(7) renewing the predetermined time value,

wherein steps (1) to (7) are repeated, and, if the sum of the plurality of primary multiplex bit amounts is larger than a predetermined bit amount, a plurality of secondary multiplex bit amounts are determined and added to the plurality of multiplex bit amounts, to multiplex the moving image encoded signals of the plurality of multiplex bit amounts.

16. A moving image multiplexing method for multiplexing a plurality of moving image encoded signals. comprising the steps of:

determining a plurality of minimum transmission amounts required for preventing underflow of a plurality of input buffers of decoding devices based on bit amounts of frames of the plurality of moving image encoded signals which have not been transmitted to the decoding devices and times required until the frames of the plurality of moving image encoded signals are decoded;
determining a plurality of transmission bit amount lower limits based on the plurality of minimum transmission amounts; and
multiplexing the plurality of transmission bit amount lower limits before multiplexing the plurality of moving image encoded signals.

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17. A moving image encoding device for encoding a plurality of moving image signals, comprising:

a plurality of encoding sections for encoding the plurality of moving image signals, each of the plurality of encoding sections including a quantization sub-section for quantizing the moving image signals with a predetermined parameter and a stuffing sub-section for stuffing the quantized moving image signals with a predetermined stuffing amount;
a quantization control section for controlling the parameters used by the quantization sub-sections simultaneously;
a plurality of accumulation sections for temporarily accumulating a plurality of moving image encoded signals output from the plurality of encoding sections;
a multiplexing section for multiplexing the plurality of moving image encoded signals accumulated in the plurality of accumulation sections and outputting the multiplexed signals at a constant bit rate;
a stuffing control section for controlling the stuffing amounts used by the stuffing sections; and
a virtual empty capacity calculation section for calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the plurality of moving image encoded signals are not input into the input buffers for the predetermined time period,
wherein the quantization control section determines the parameters used by the quantization sub-sections based on a sum of the bit amounts of the plurality of moving image encoded signals, and
the stuffing control section controls each of the stuffing sections based on a sum of the bit amounts of the moving image encoded signals accumulated in the plurality of accumulation sections, the constant bit rate, and a difference between the bit amount of each of the moving image encoded signals accumulated in the accumulation section and the empty capacity of the input buffer obtained by the virtual empty capacity calculation section.

18. A moving image encoding method for encoding a plurality of moving image signals simultaneously using predetermined quantization widths each based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and an output bit amount of each of the plurality of moving image encoded signals output after being temporarily accumulated,

wherein a plurality of encoded buffer occupations of the moving image encoded signals temporarily accumulated are calculated,
an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the moving image encoded signals are not input into the input buffers for the predetermined time period is calculated; and
for each of the moving image encoded signals where a buffer differential value obtained by subtracting the empty capacity of the input buffer from the encoded buffer occupation is smaller than a predetermined value, a signal of a bit amount obtained by adding the buffer differential value larger than the predetermined value which does not influence the encoding is distributed to the moving image encoded signals where the buffer differential value is smaller than the predetermined value to effect stuffing.

19. A moving image encoding method according to claim 18, wherein the predetermined value is 0.

20. A moving image encoding device for encoding a plurality of moving image signals, comprising:

a plurality of encoding sections for encoding the plurality of moving image signals, each of the plurality of encoding sections including a quantization sub-section for quantizing the moving image signals with a predetermined parameter;
a quantization control section for controlling the parameters used by the quantization sub-sections simultaneously;
a plurality of accumulation sections for temporarily accumulating a plurality of moving image encoded signals output from the plurality of encoding sections;
a multiplexing section for multiplexing the plurality of moving image encoded signals accumulated in the plurality of accumulation sections and outputting the multiplexed signals at a constant bit rate; and
a virtual empty capacity calculation section for calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the plurality of moving image encoded signals are not input into the input buffers for the predetermined time period,
wherein the quantization control section determines each of the parameters used by the quantization sub-sections based on a sum of the bit amounts of the moving image encoded signals accumulated in the plurality

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of accumulation sections, the constant bit rate, and a difference between the bit amount of the moving image encoded signal accumulated in the accumulation section and the empty capacity of the input buffer obtained by the virtual empty capacity calculation section.

21. A moving image encoding method for encoding a plurality of moving image signals simultaneously using predetermined quantization widths each based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and an output bit amount of each the plurality of moving image encoded signals output after being temporarily accumulated, comprising the steps of:

calculating a plurality of encoded buffer occupations of the moving image encoded signals temporarily accumulated,
calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the moving image encoded signals are not input into the input buffers for the predetermined time period; and
encoding each of the moving image encoded signals where a buffer differential value obtained by subtracting the empty capacity of the input buffer from the encoded buffer occupation is smaller than a predetermined value using a quantization width smaller than the corresponding predetermined quantization width.

22. A moving image encoding method according to claim 21, wherein the predetermined value is 0.

23. A moving image encoding method for encoding a plurality of moving image signals simultaneously using predetermined quantization widths each based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and an output bit amount of each the plurality of moving image encoded signals output after being temporarily accumulated, comprising the steps of:

calculating a plurality of encoded buffer occupations of the moving image encoded signals temporarily accumulated,
calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the moving image encoded signals are not input into the input buffers for the predetermined time period; and
encoding each of the moving image encoded signals where a buffer differential value obtained by subtracting the empty capacity of the input buffer from the encoded buffer occupation is larger than a predetermined value using a quantization width larger than the corresponding predetermined quantization width.

24. A moving image encoding method according to claim 23, wherein the predetermined value is 0.

25. A moving image encoding method for encoding a plurality of moving image signals simultaneously using predetermined quantization widths each based on a difference between a sum of bit amounts of a plurality of moving image encoded signals generated by encoding the plurality of moving image signals and an output bit amount of each the plurality of moving image encoded signals output after being temporarily accumulated, comprising the steps of:

calculating a plurality of encoded buffer occupations of the moving image encoded signals temporarily accumulated,
calculating an empty capacity of each of a plurality of input buffers of decoding devices after a lapse of a predetermined time period when the moving image encoded signals are not input into the input buffers for the predetermined time period; and
calculating a buffer differential value obtained by subtracting the empty capacity of the input buffer from the encoded buffer occupation for each of the moving image encoded signals-, and adding a sum of the buffer differential values which are larger than a predetermined value to the sum of the bit amounts.

26. A moving image encoding method according to claim 25, wherein the predetermined value is 0.

27. A moving image encoding and multiplexing device for encoding a plurality of moving image signals and multiplexing the encoded signals, comprising:

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a moving image switch section for switching a destination of a plurality of input moving images;
a plurality of encoding sections for encoding the plurality of input moving images output from the moving image switch section;
a multiplexing section for multiplexing the encoded signals output from the plurality of encoding sections; and
a control section for switching a switching state of the moving image switch section, an encoding mode of the encoding sections, and a multiplexing mode of the multiplexing sections;
wherein the control section switches the encoding mode of the encoding sections and the multiplexing mode of the multiplexing sections depending on the switching state of the moving image switch section.

28. A moving image encoding and multiplexing device according to claim 27, wherein the control section comprises: a switch control sub-section for switching the switching state of the moving image switch section; an encoding control sub-section for switching the encoding mode of the encoding section; and a multiplexing control sub-section for switching the multiplexing mode of the multiplexing section, and

the encoding control sub-section switches the encoding mode depending on the switching state of the moving image switch section, and the multiplexing control sub-section switches the multiplexing mode depending on the switching state of the moving image switch section.

29. A moving image encoding and multiplexing device according to claim 27, further comprising a screen division section upstream of the moving image switch section.

30. A moving image encoding and multiplexing device according to claim 27, further comprising a moving image time-division section upstream of the moving image switch section.

31. A moving image encoding and multiplexing device according to claim 27, further comprising accumulation sections for temporarily accumulating "moving image encoded signals output from the encoding sections,

wherein the encoding control sub-section determines a parameter for controlling each of the encoding sections based on a sum of bit amounts of the moving image encoded signals accumulated in the accumulation sections.

32. A moving image encoding and multiplexing device according to claim 27, wherein the multiplexing section comprises: a moving image multiplexing sub-section for multiplexing the plurality of moving image encoded signals and outputting a moving image encoded signal; a channel multiplexing sub-section for multiplexing a plurality of input signals input into the multiplexing section and the output signal output from the moving image multiplexing sub-section; and a switch sub-section for switching the destination of the moving image encoded signals input into the multiplexing section between the moving image multiplexing sub-section and the channel multiplexing sub-section.

33. An image transmission device comprising a plurality of image encoding sections and a transmission processing section, wherein

the transmission processing section multiplexes encoded data specified by the image encoding sections every multiplexing timing, transmits the encoded data to a predetermined route, and sends to the image encoding sections multiplexing information which is calculated based on encoded data amount in the image encoding sections and can be used for calculation of a delay amount taken until the encoded data is transmitted to a decoding device, and
the plurality of image encoding sections determine quantization widths used at quantization in an image encoding processing based on the multiplexing information sent from the transmission processing section, encode the images, and transmit the encoded data to the transmission processing section every multiplexing timing to specify the encoded data.

34. An image transmission device according to claim 33, wherein the transmission processing section comprises a transmission buffer, and

the transmission processing section takes the encoded data specified by the image encoding sections in the transmission buffer every multiplexing timing, and outputs the encoded data at a predetermined transmission rate in the order of the taking-in of the encoded data, as well as outputting an occupation of the encoded data in the transmission buffer as multiplexing information.

35. An image transmission device according to claim 33, wherein each of the image encoding sections includes: a

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quantization width determination sub-section; and a basic encoding processing sub-section for encoding images by quantizing the images with a quantization width specified by the quantization width determination sub-section, and

the quantization width determination sub-section calculates a buffer occupation in each of a plurality of decoding devices which receive the encoded data transmitted from each of the image encoding sections via the transmission processing section based on the multiplexing information, and sets the quantization width based on the calculated buffer occupation in the decoding device and an amount of encoded data which has not been transmitted.

36. An image transmission device according to claim 33,' wherein each of the image encoding sections further includes an encoded data memory sub-section for temporarily storing the encoded data, and

the encoded data memory sub-section temporarily stores non-transmitted data which has not been transmitted to the transmission processing section among the encoded data every transmission timing, and transmits the encoded data to the transmission processing section using as an upper limit a value preset by each of the image encoding sections or a value obtained by subtracting the buffer occupation in the decoding device calculated based on the multiplexing information from a buffer size of the decoding device predicted by the receiver side.

37. An image transmission device comprising a transmission processing section for receiving encoded data from a plurality of image encoding sections,

wherein the transmission processing section comprises a transmission buffer, takes the encoded data specified by the image encoding sections in the transmission buffer every multiplexing timing, and outputs the encoded data at a predetermined transmission rate in the order of the taking-in of the encoded data, as well as outputting an occupation of the encoded data in the transmission buffer as multiplexing information.

38. An image encoding device comprising a quantization width determination section and a basic encoding processing section for encoding images by quantizing the images with a quantization width specified by the quantization width determination section,

wherein the quantization width determination section determines the quantization width based on multiplexing information which can be used for calculation of a delay amount taken until encoded data is transmitted to a virtual decoding device, a buffer occupation in the virtual decoding device calculated based on the multiplexing information, and an amount of encoded data which has not been transmitted.

39. An image encoding device according to claim 38, further comprising an encoded data memory section for temporarily storing the encoded data,

wherein the encoded data memory section temporarily stores non-transmitted data which has not been transmitted among the encoded data every transmission timing, and outputs the encoded data using as an upper limit a value preset by each of the image encoding sections or a value obtained by subtracting the buffer occupation in the virtual decoding device calculated based on the multiplexing information from a buffer size of the decoding device predicted by the receiver side.

40. An image transmission device comprising a bit rate management section for managing a bit rate at a transmission route and one or more image encoding sections:

wherein the bit rate management section determines a bit rate representing a total of transmission rates at the one or more image encoding sections on the transmission route, allows for transmission of encoded data requested to be transmitted by any of the image encoding sections every transmission timing, and sends transmission information regarding a transmission delay which varies with the allowance to another image encoding section on the transmission route, and

the one or more image encoding sections encode images by quantizing the images with a quantization width determined based on the transmission information, non-transmitted encoded data, and a predicted buffer size on the receiver side.

41. An image transmission device comprising a bit rate management section for managing transmission rates of a plurality of image encoding sections,

wherein the bit rate management section determines a bit rate representing a total of transmission rates at all the image encoding sections on a transmission route, allows for transmission of encoded data requested to be transmitted by any of the image encoding sections every transmission timing, and sends transmission information regarding a transmission delay which varies with the allowance to another one of the image encoding sections on

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the transmission route.

42. An image encoding device for setting a quantization width used for quantization based on transmission information regarding a transmission delay which varies with an allowable transmission amount, non-transmitted encoded data, and a predicted buffer size on the receiver side.

43. An image encoding method comprising the steps of:

(1) determining a quantization width; and
(2) encoding images by quantizing the images with the quantization width specified in step (I),

wherein in step (1) the quantization width is set based on multiplexing information which can be used to calculate a delay amount taken until encoded data is transmitted to a virtual decoding device, a buffer occupation in the virtual decoding device calculated based on the multiplexing information, and an amount of encoded data which has not been transmitted.

44. An image encoding method according to claim 43, wherein non-transmitted data which has not been transmitted among the encoded data is temporarily stored every transmission timing, and the encoded data is output using as an upper limit a value preset by each of the image encoding sections or a value obtained by subtracting the buffer occupation in the decoding device calculated based on the multiplexing information from the buffer size of the decoding device predicted by the receiver side.

45. An image encoding method comprising encoding images by setting a quantization width used for quantization based on transmission information regarding a transmission delay which varies with an allowable transmission amount, non-transmitted encoded data, and a predicted buffer size on the receiver side.

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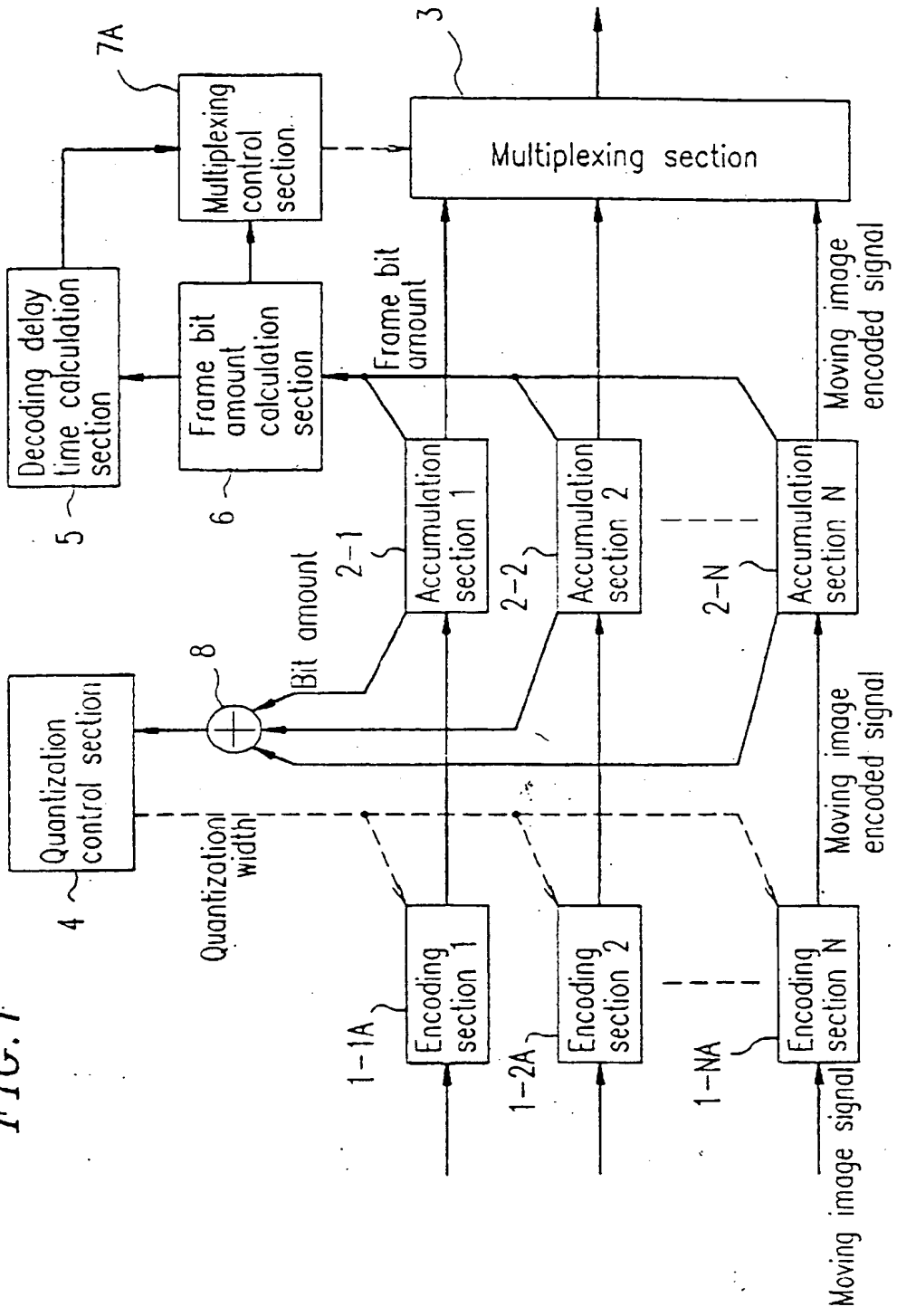

FIG. 1

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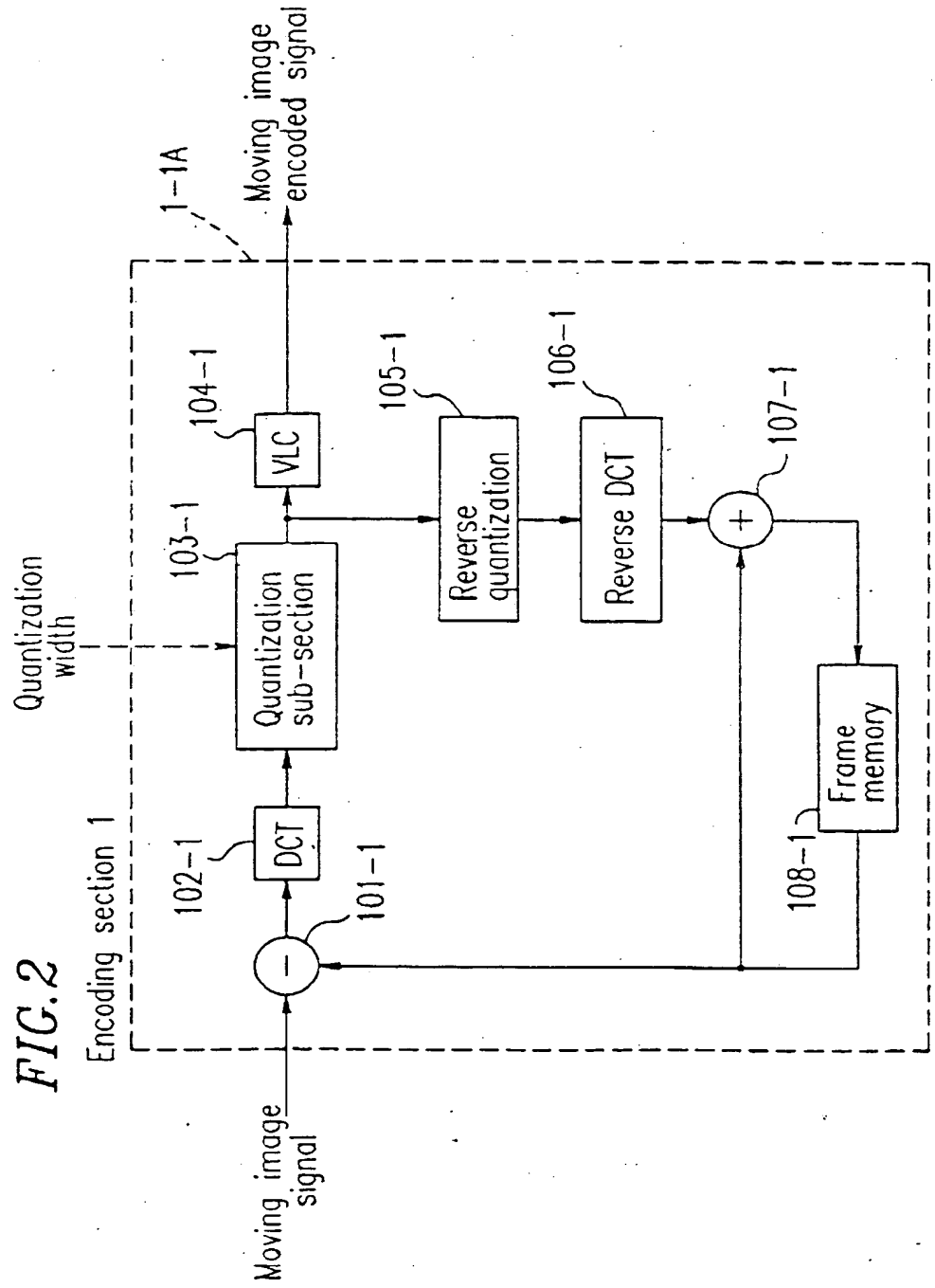

FIG.2

BNSDOCID <EP 0841820A2 I >

FIG. 3

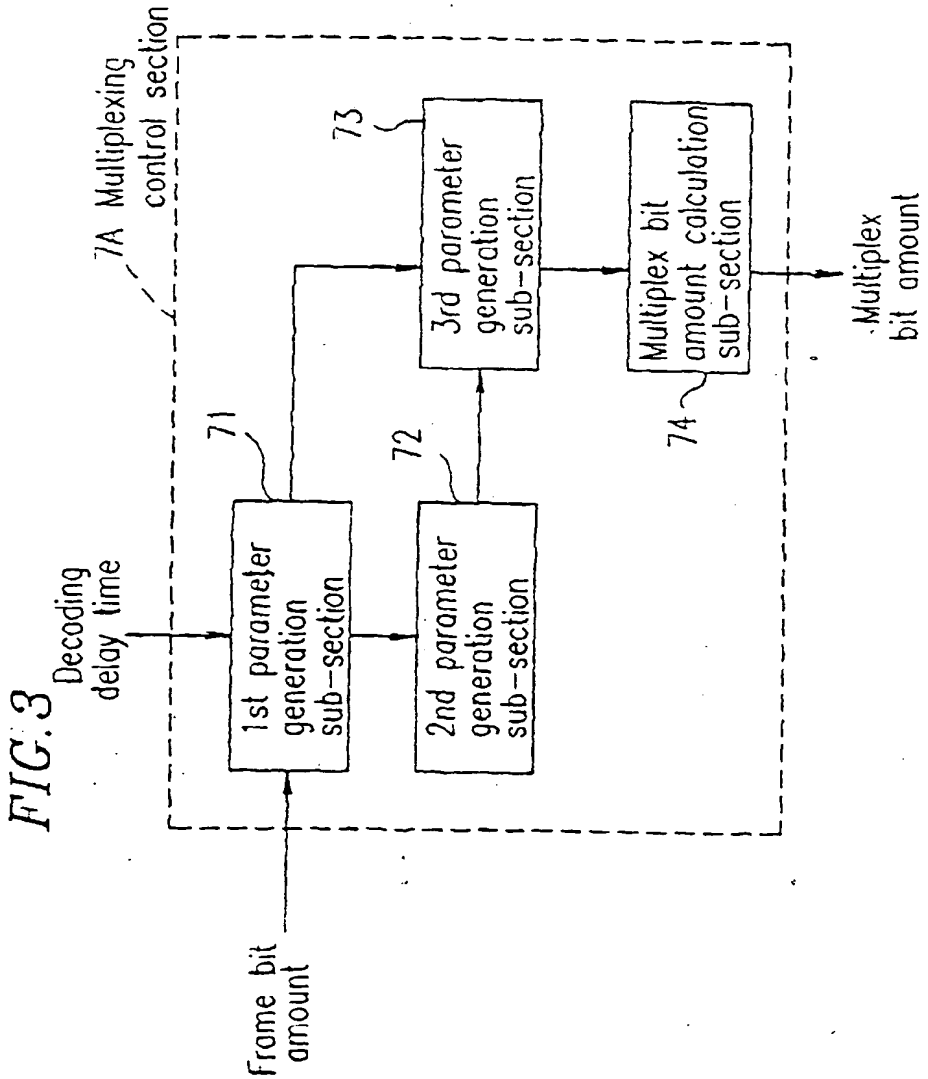

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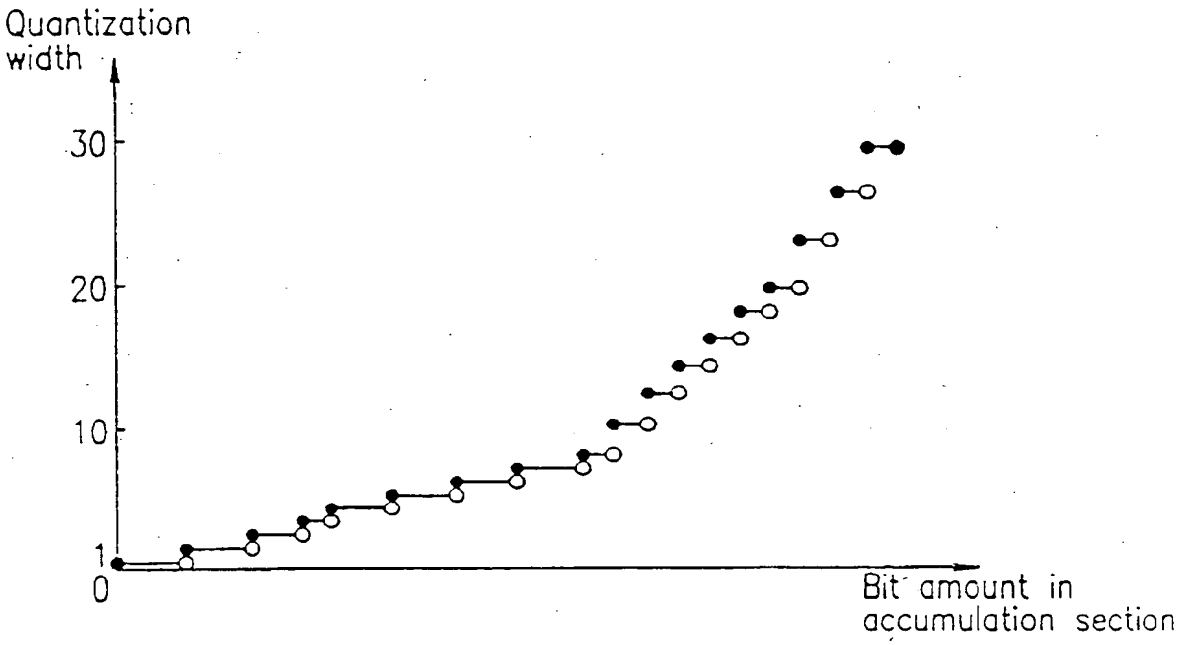
FIG. 4



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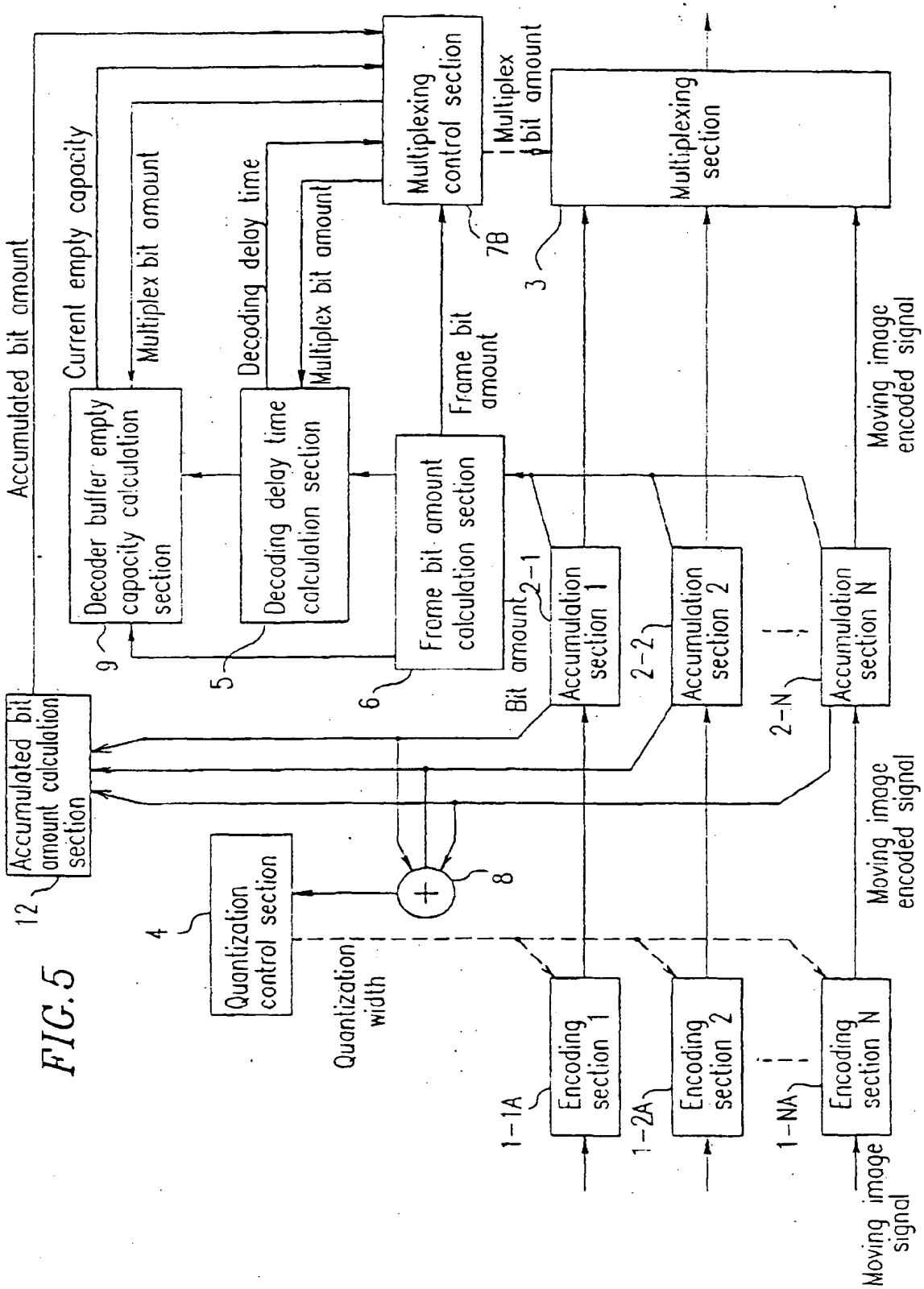

FIG. 5

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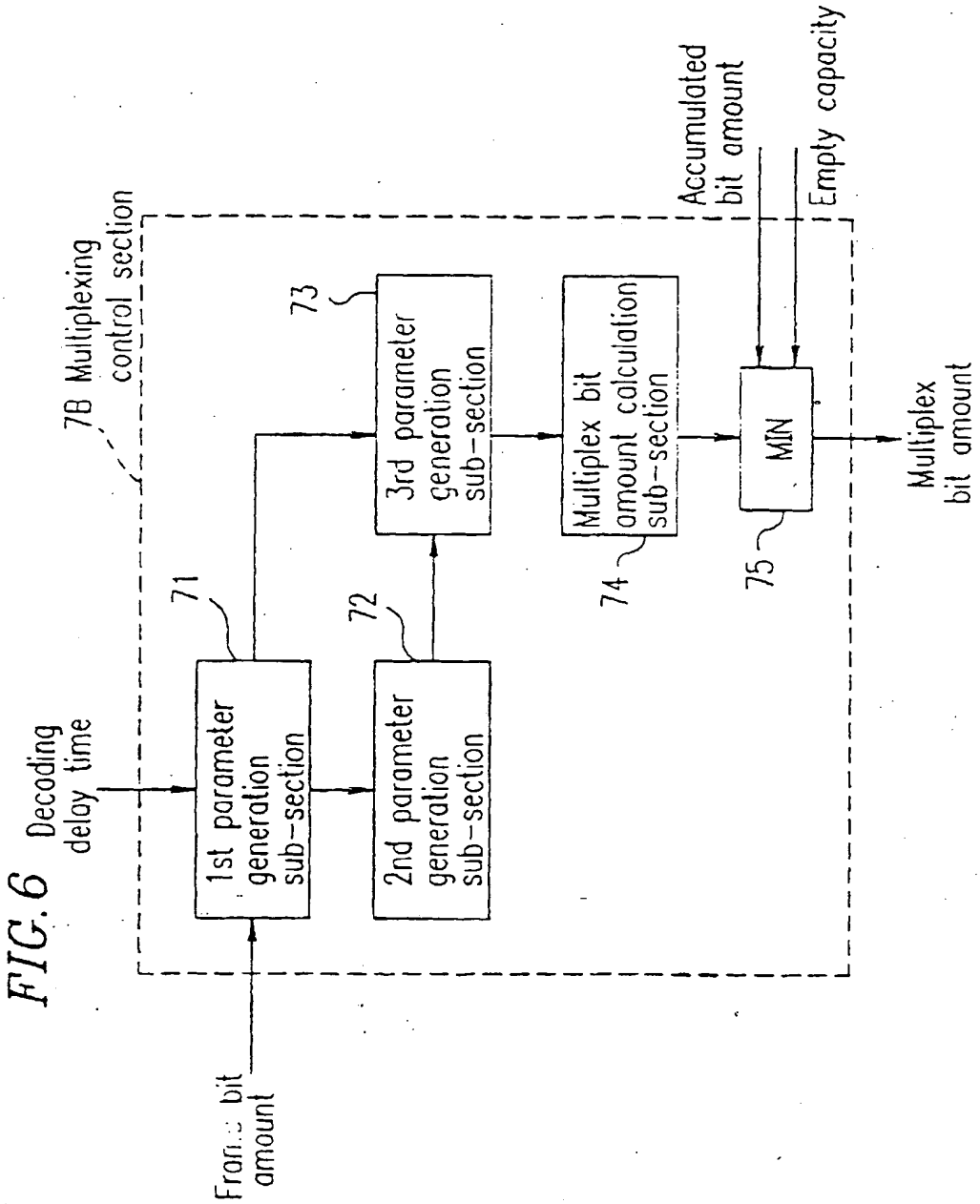

FIG. 6

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FIG. 7

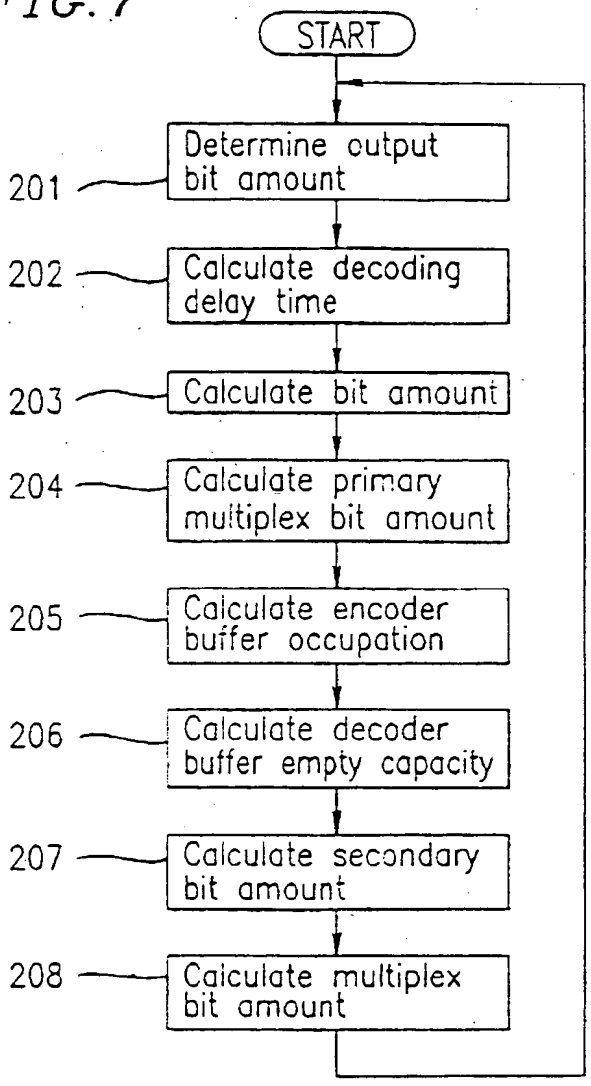

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FIG. 8

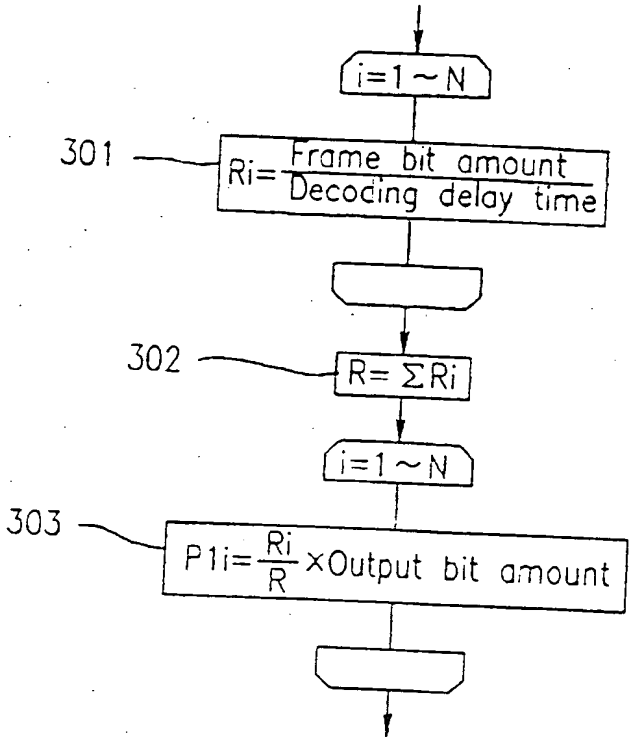

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FIG. 9

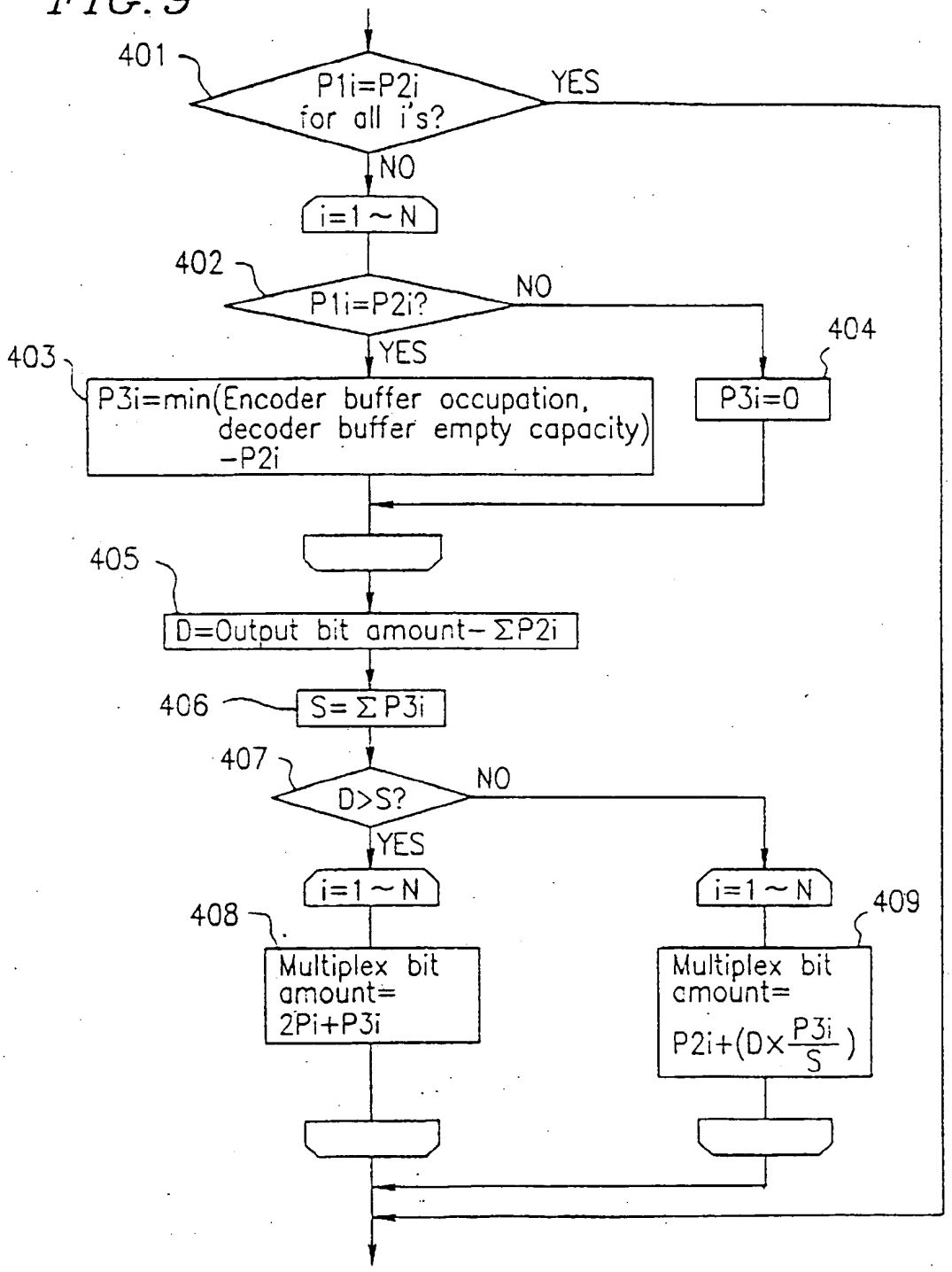

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FIG. 10

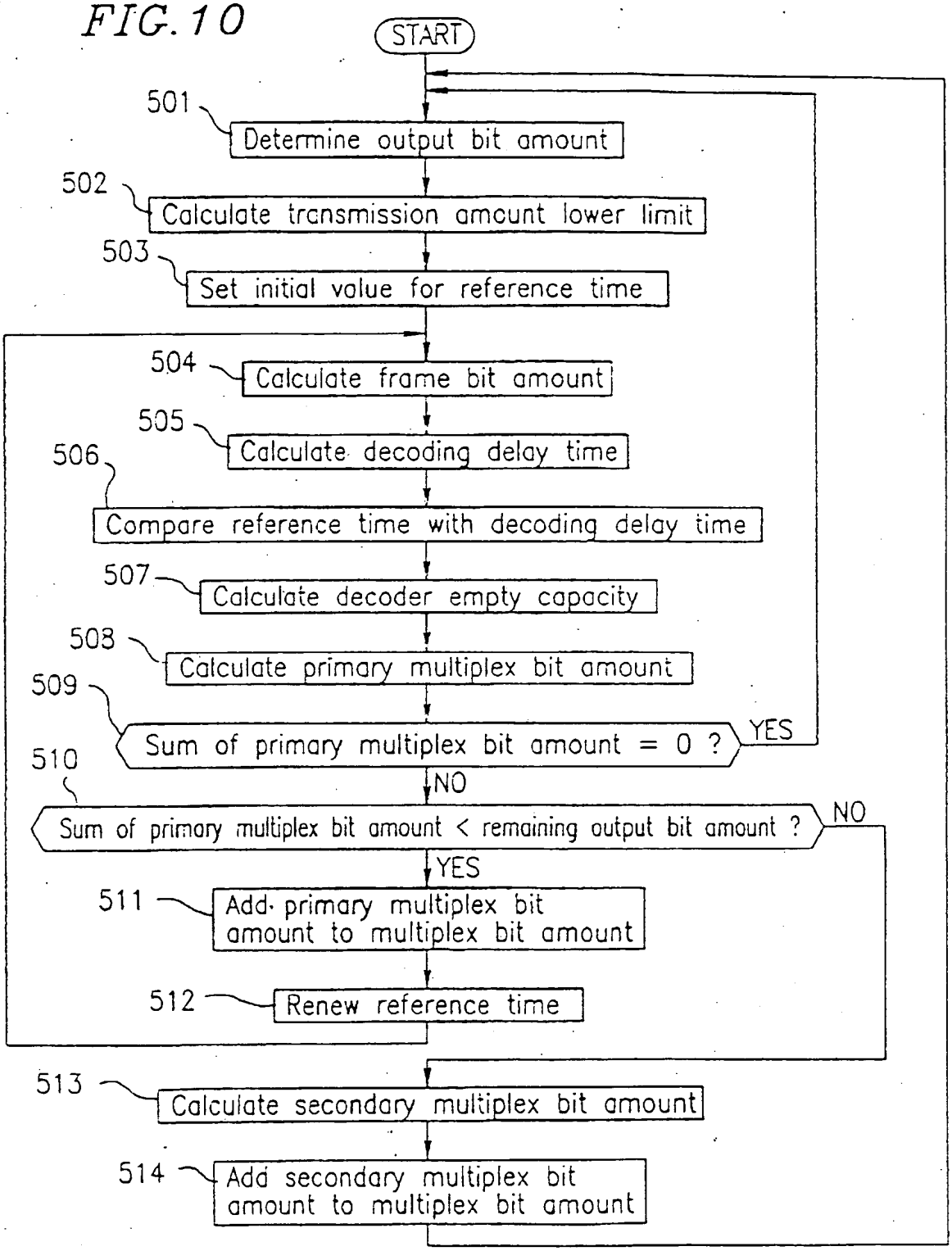

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FIG. 11A

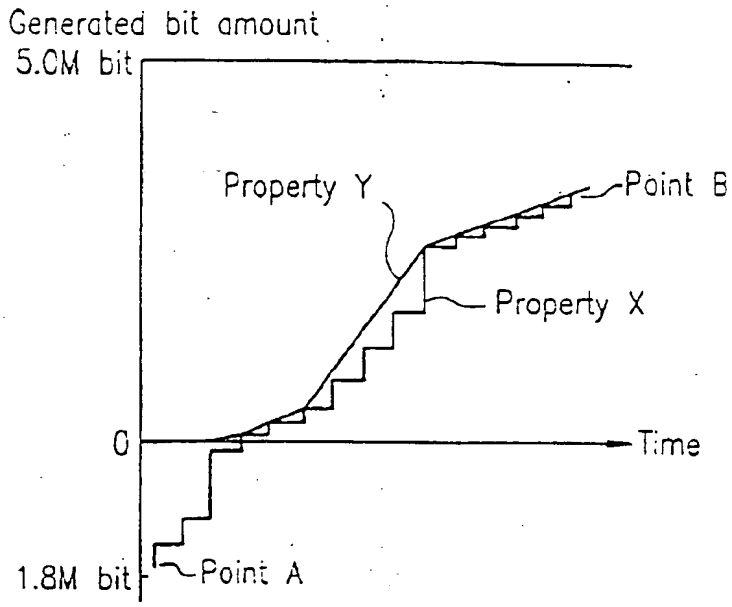


FIG. 11B

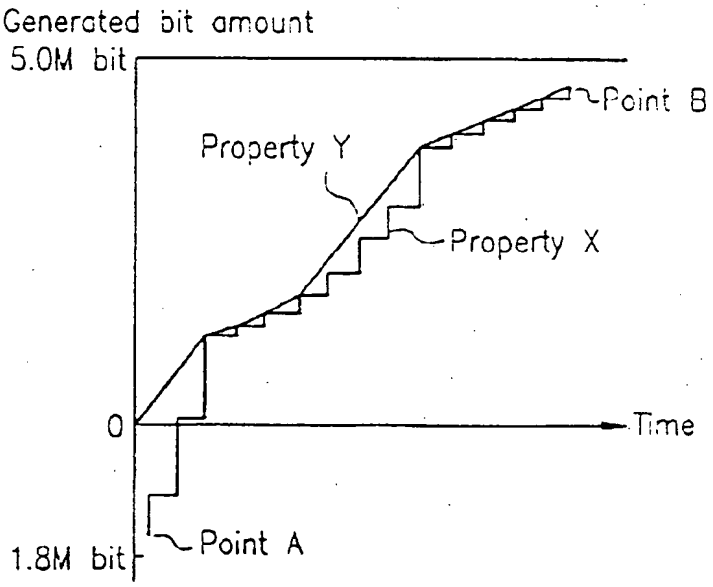
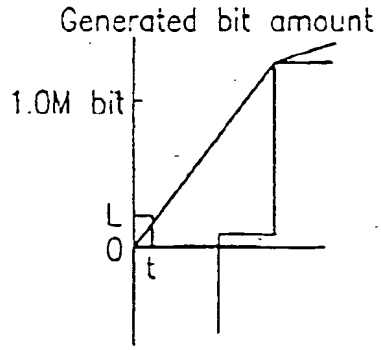


FIG. 11C



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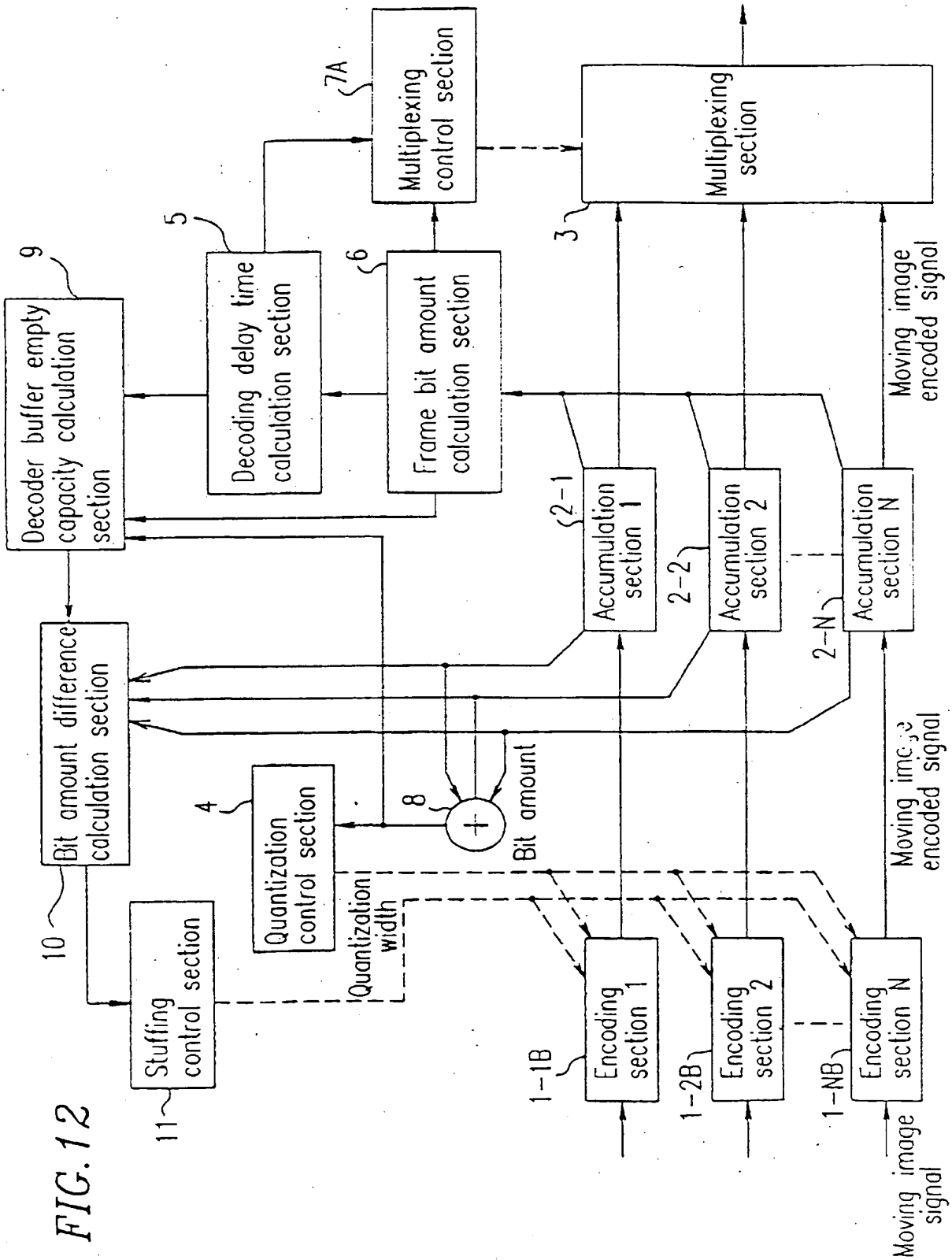

FIG. 12

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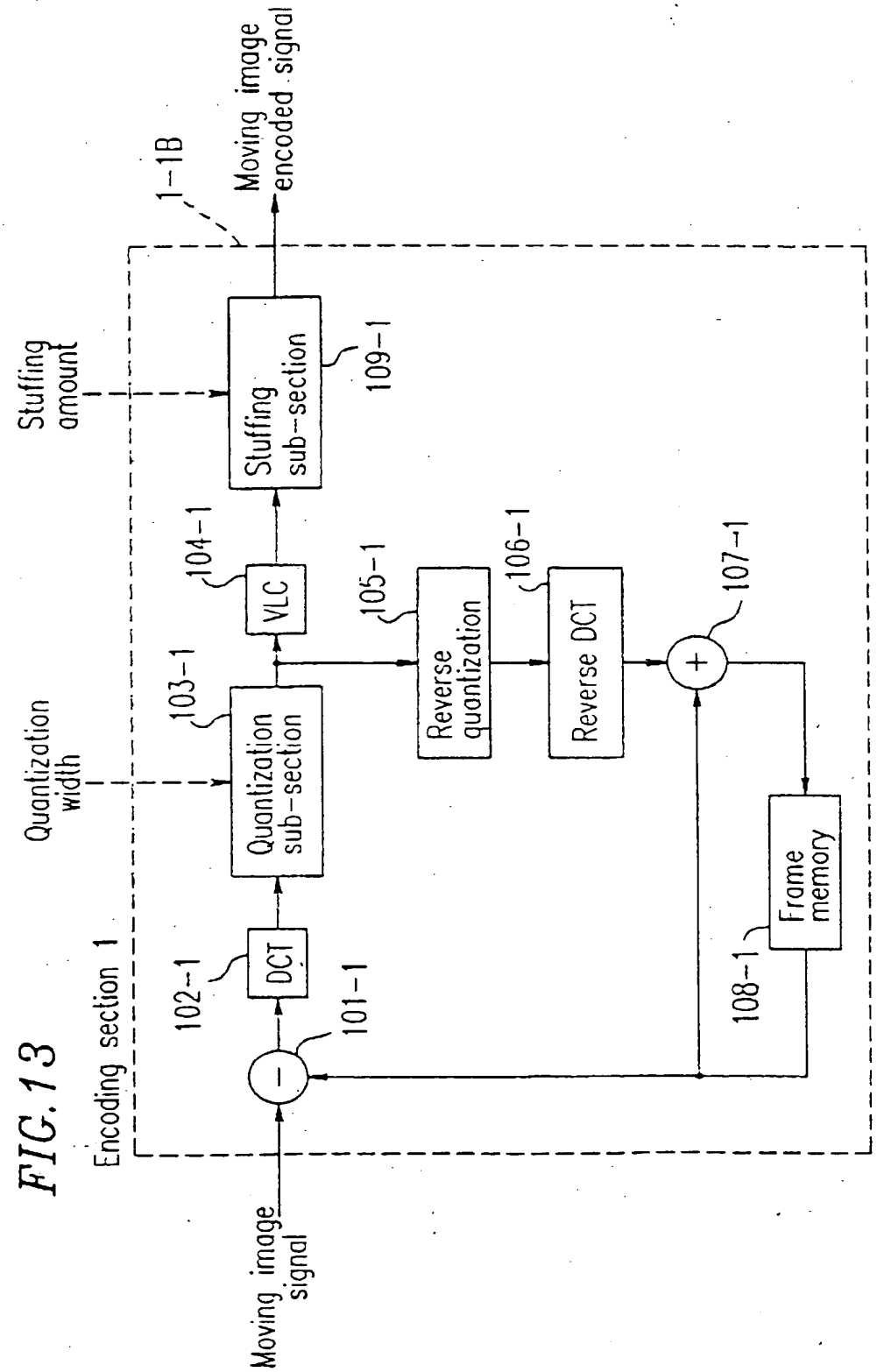

FIG. 13

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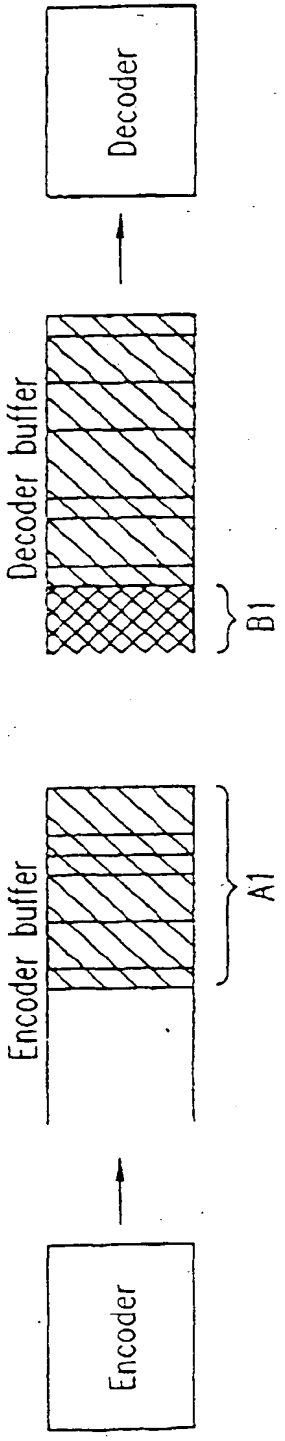

FIG. 14A.

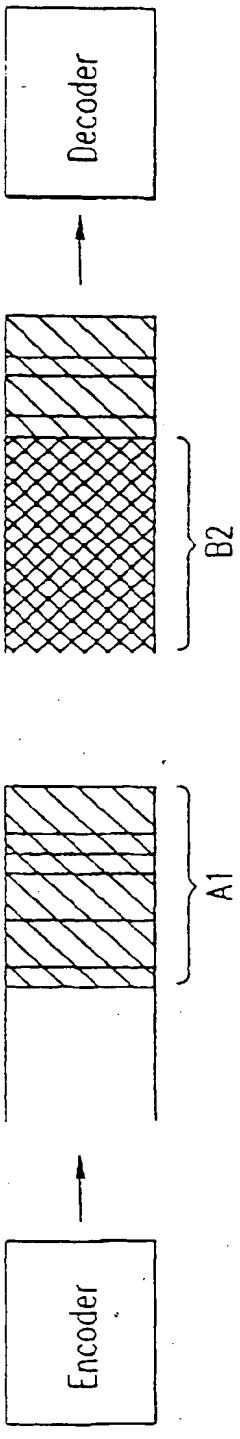

FIG. 14B

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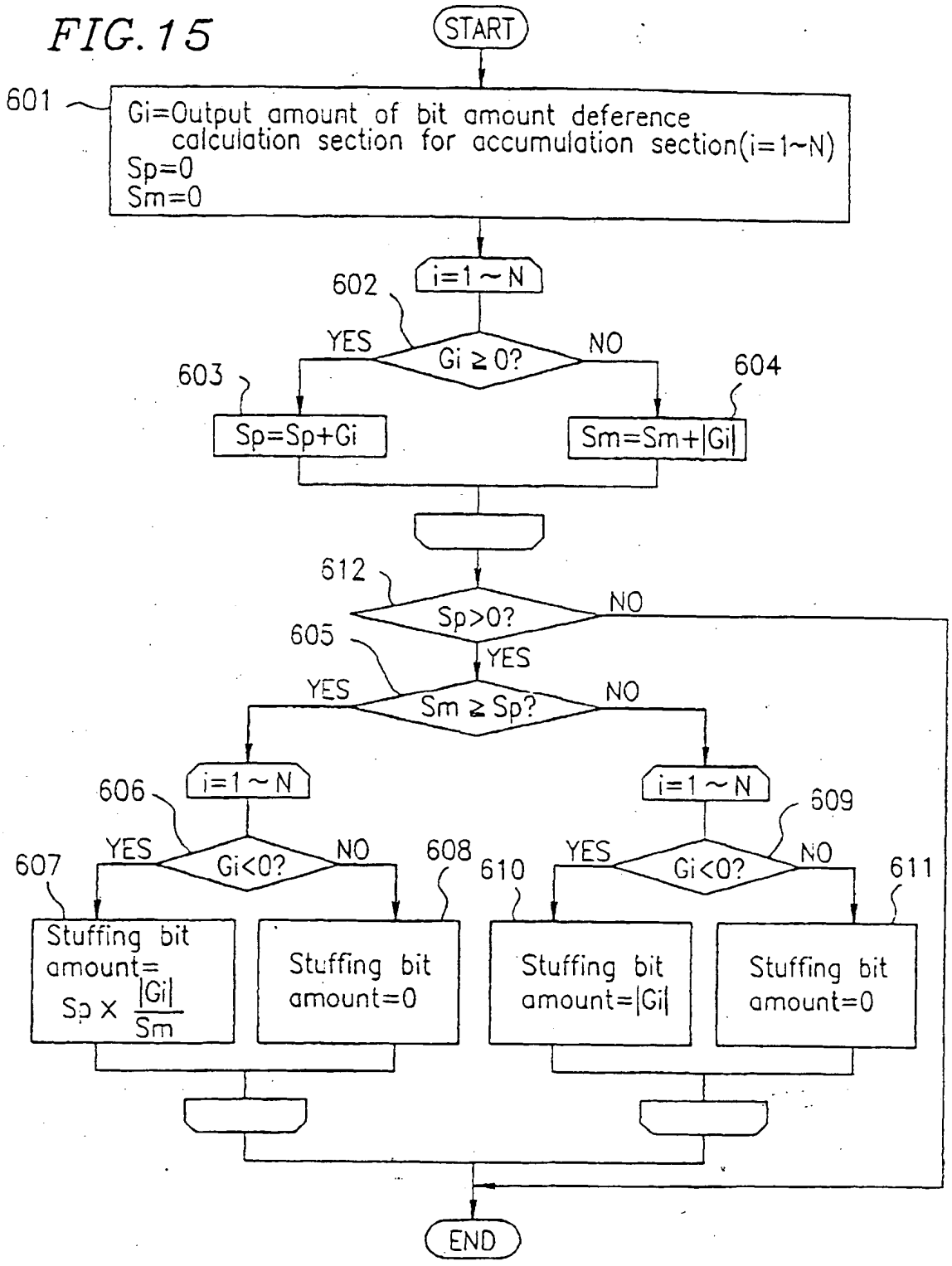
FIG. 15



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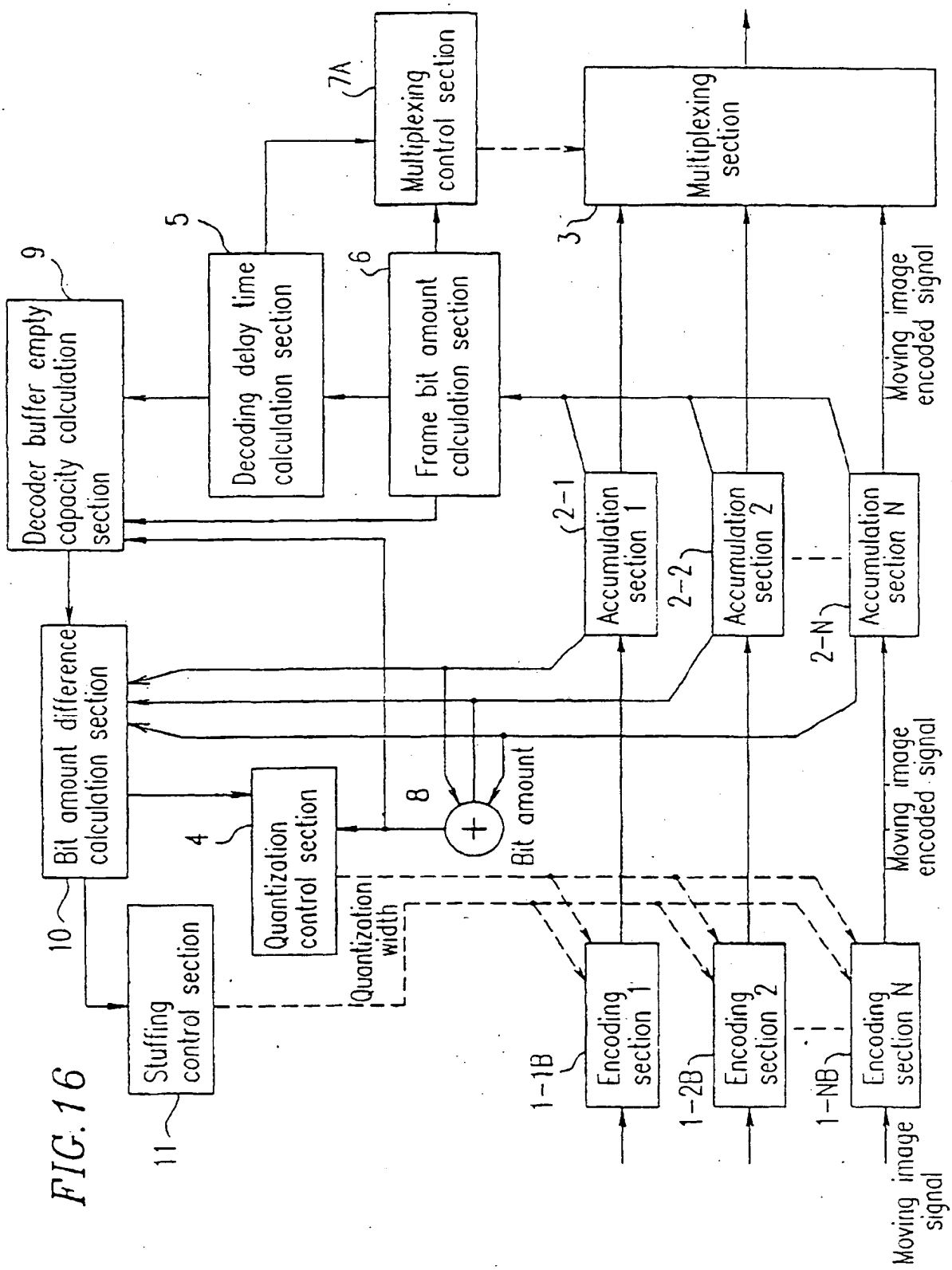

FIG. 16

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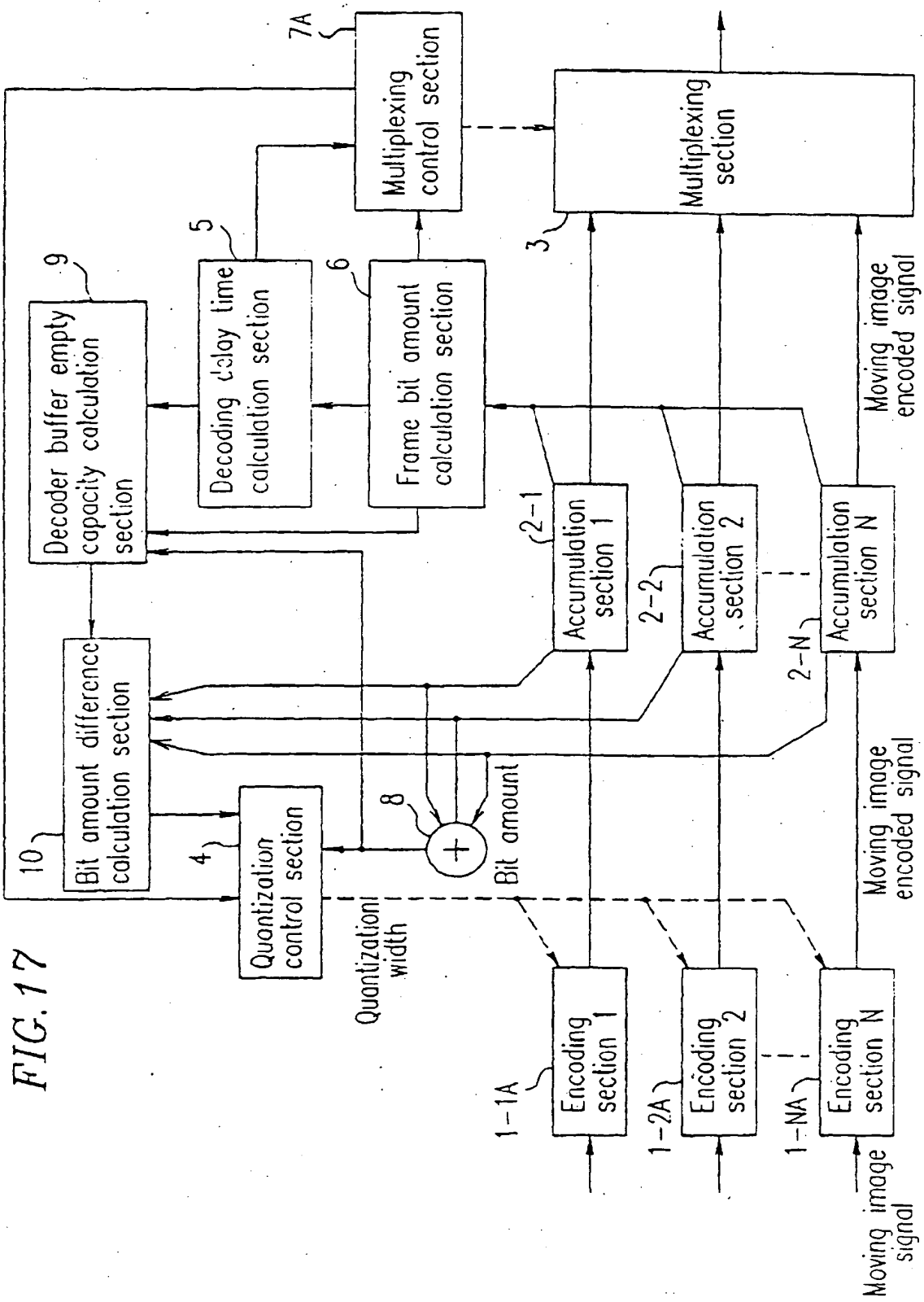

FIG. 17

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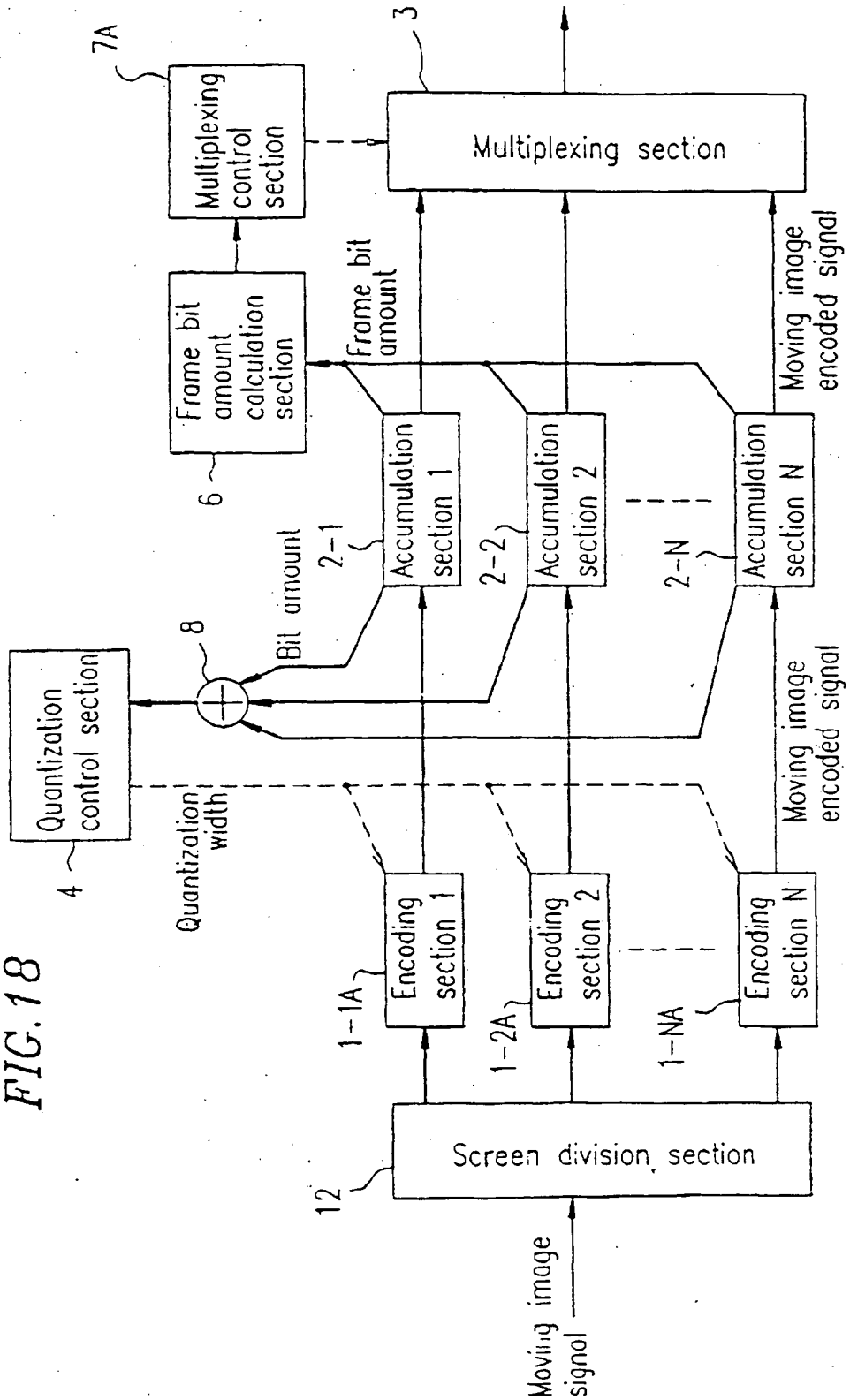

FIG. 18

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FIG. 19

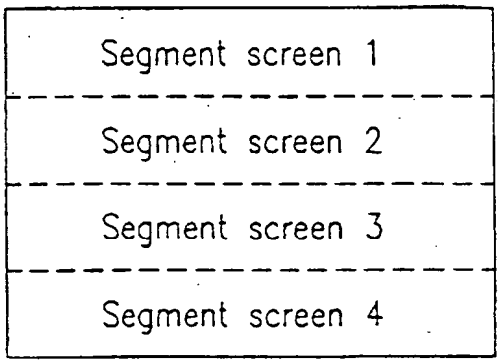

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FIG. 20

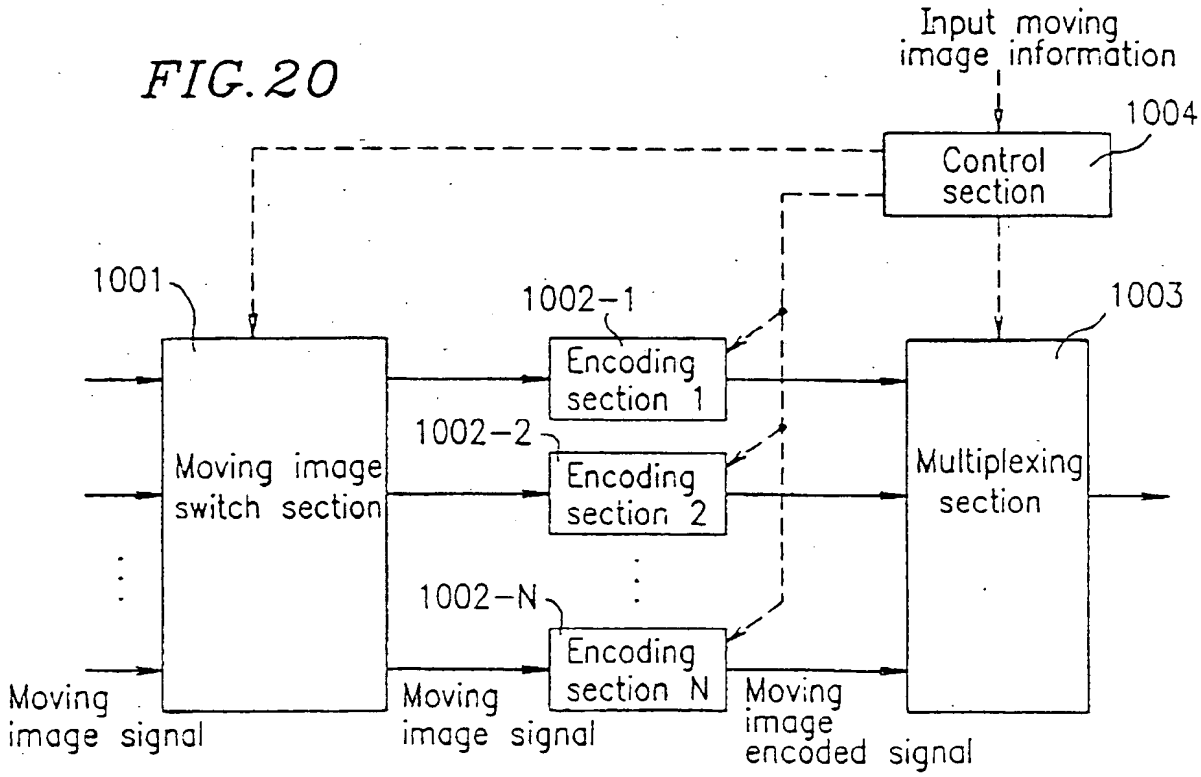

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FIG. 21

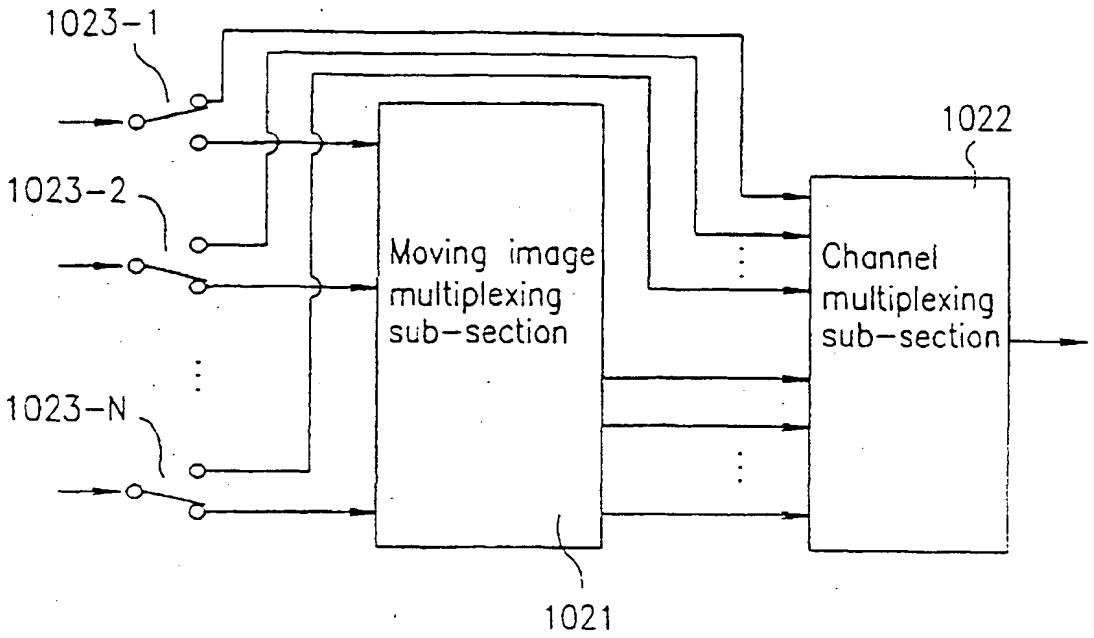
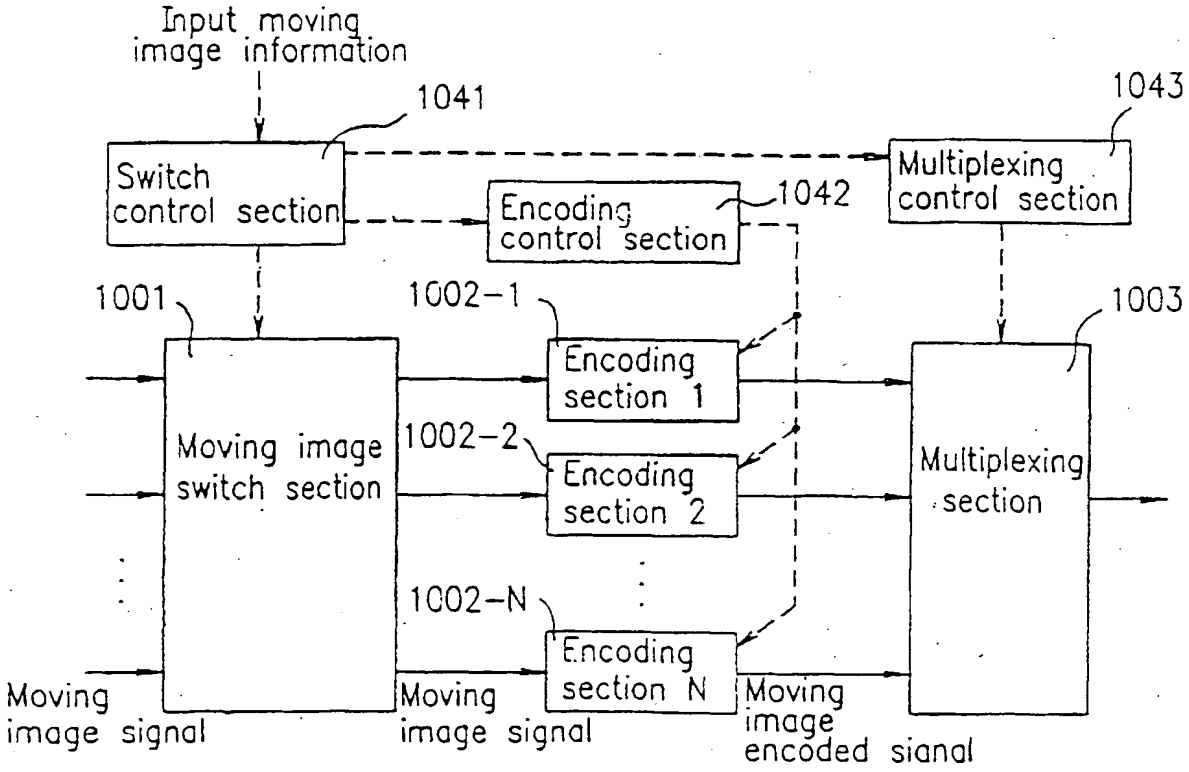


FIG. 22



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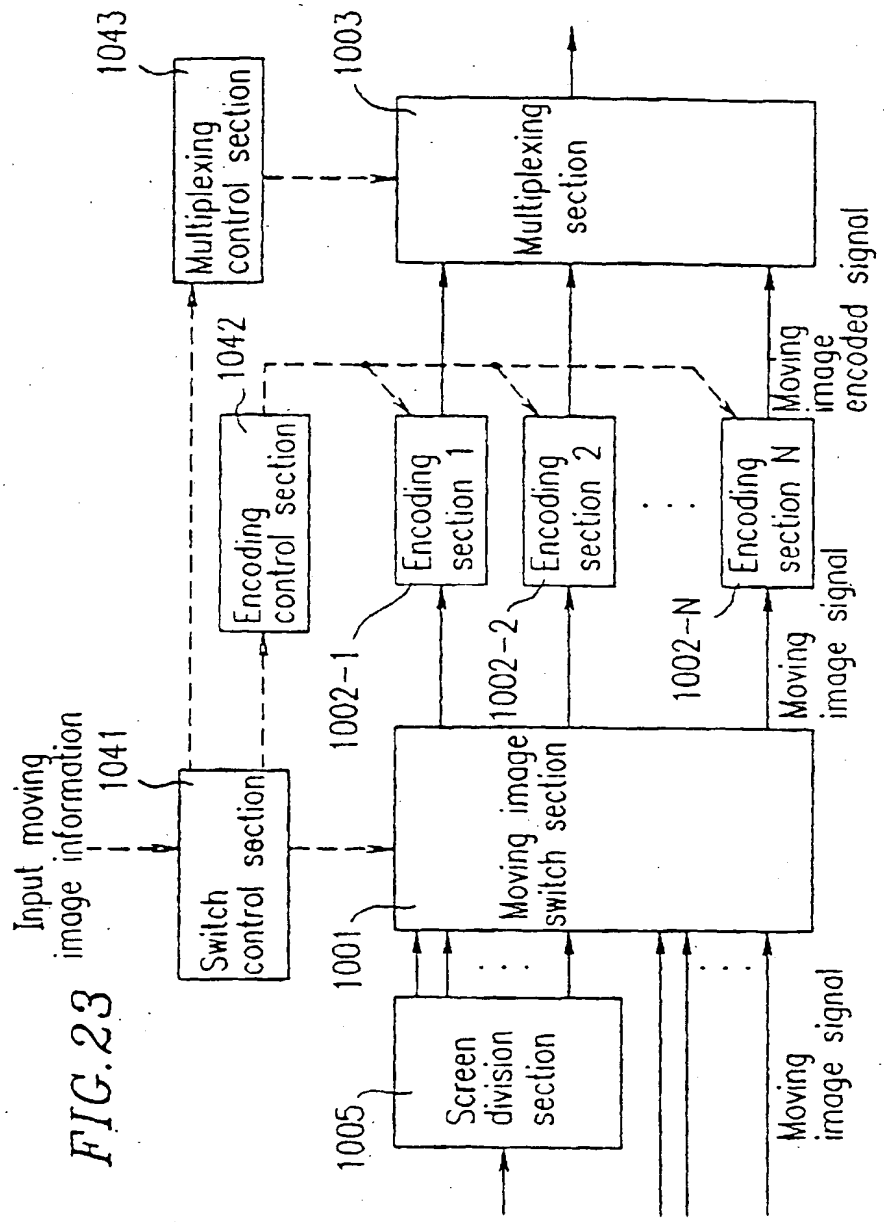

FIG. 23

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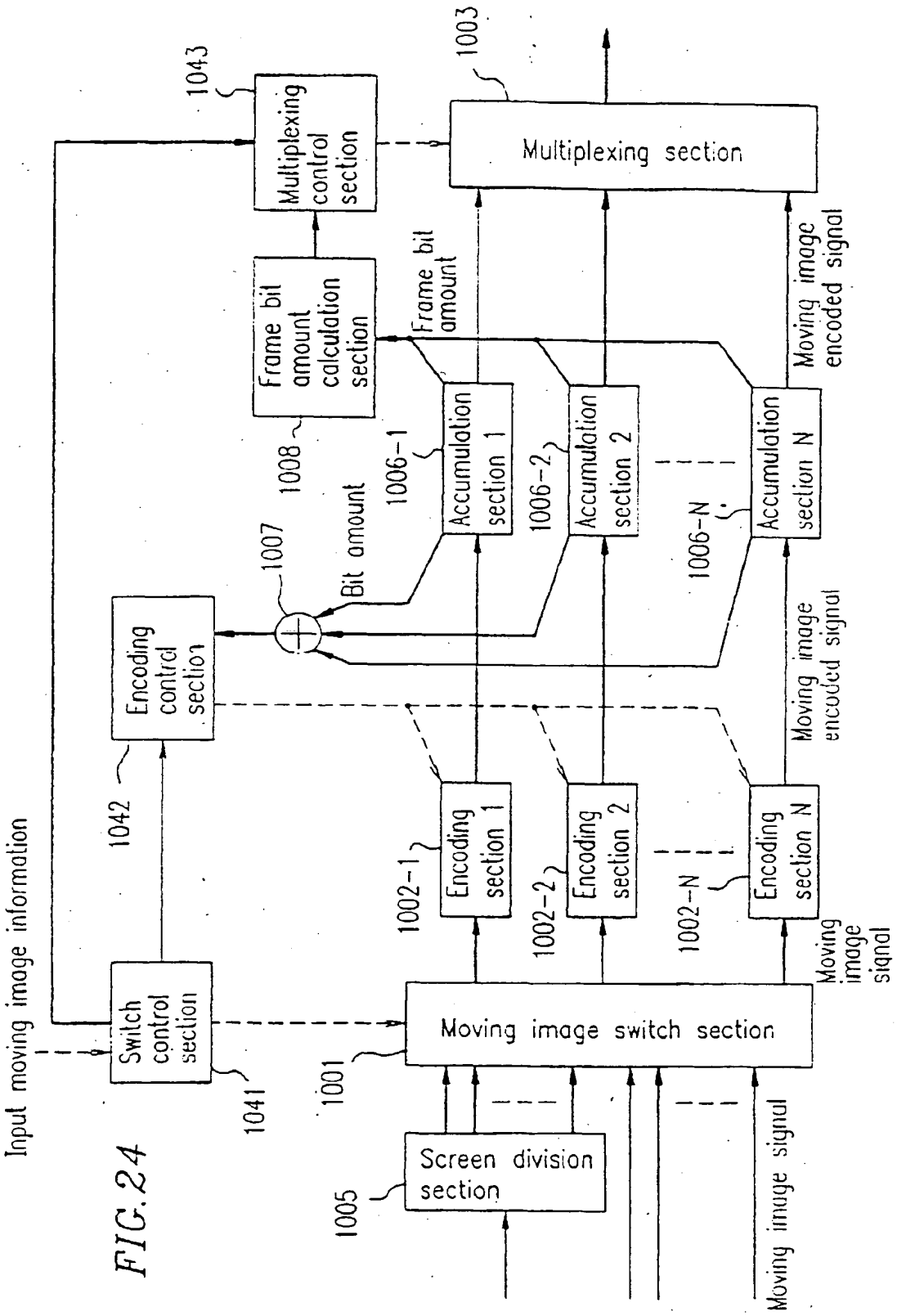

FIG. 24

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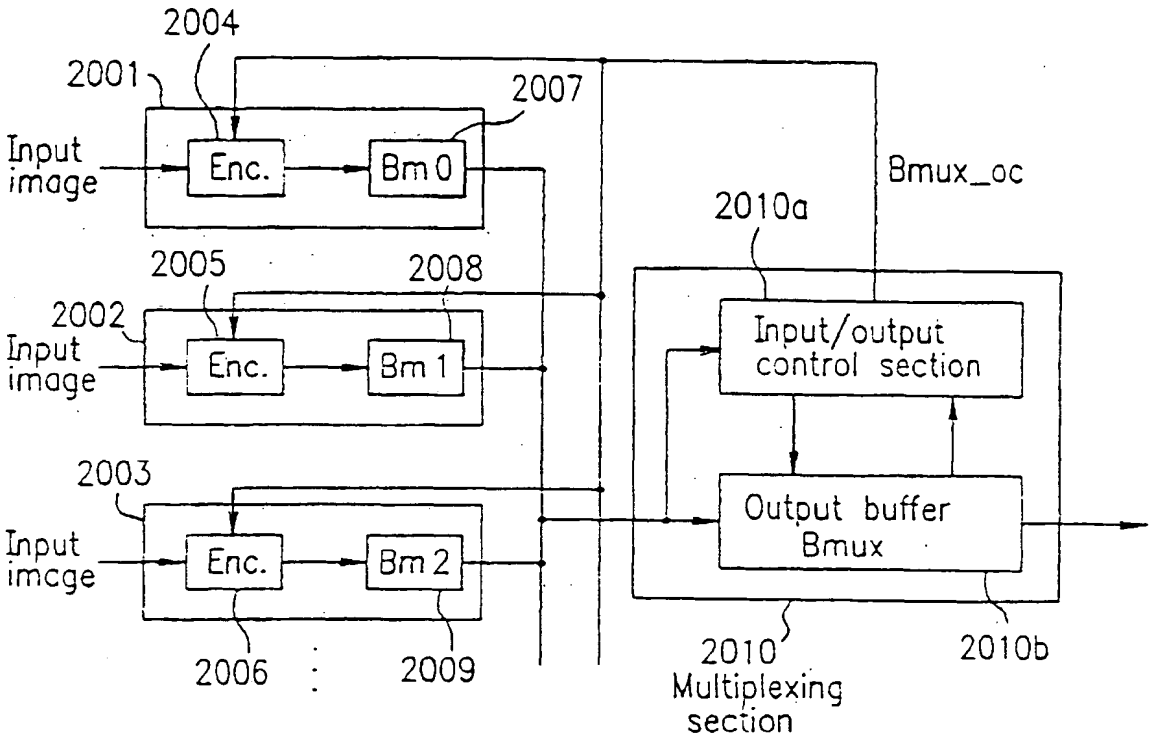
FIG.25



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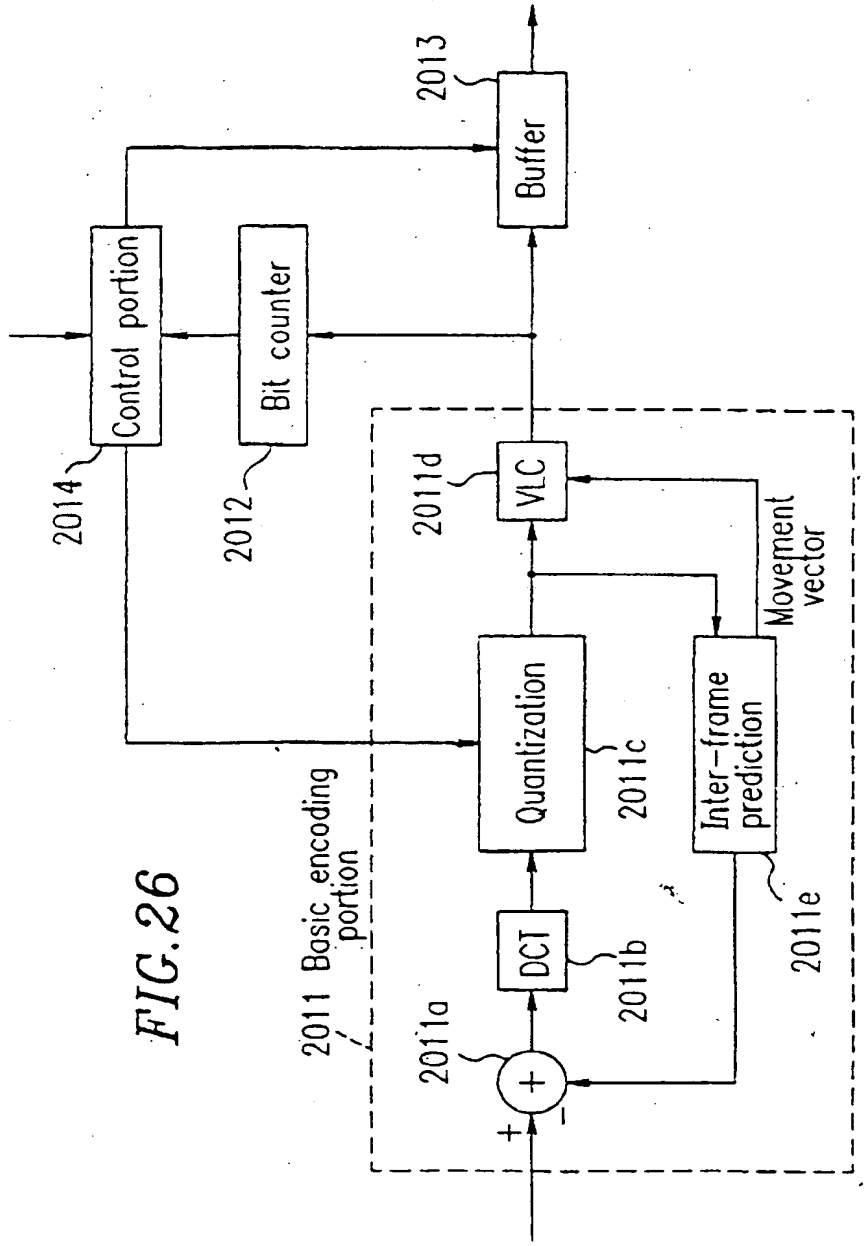

FIG. 26

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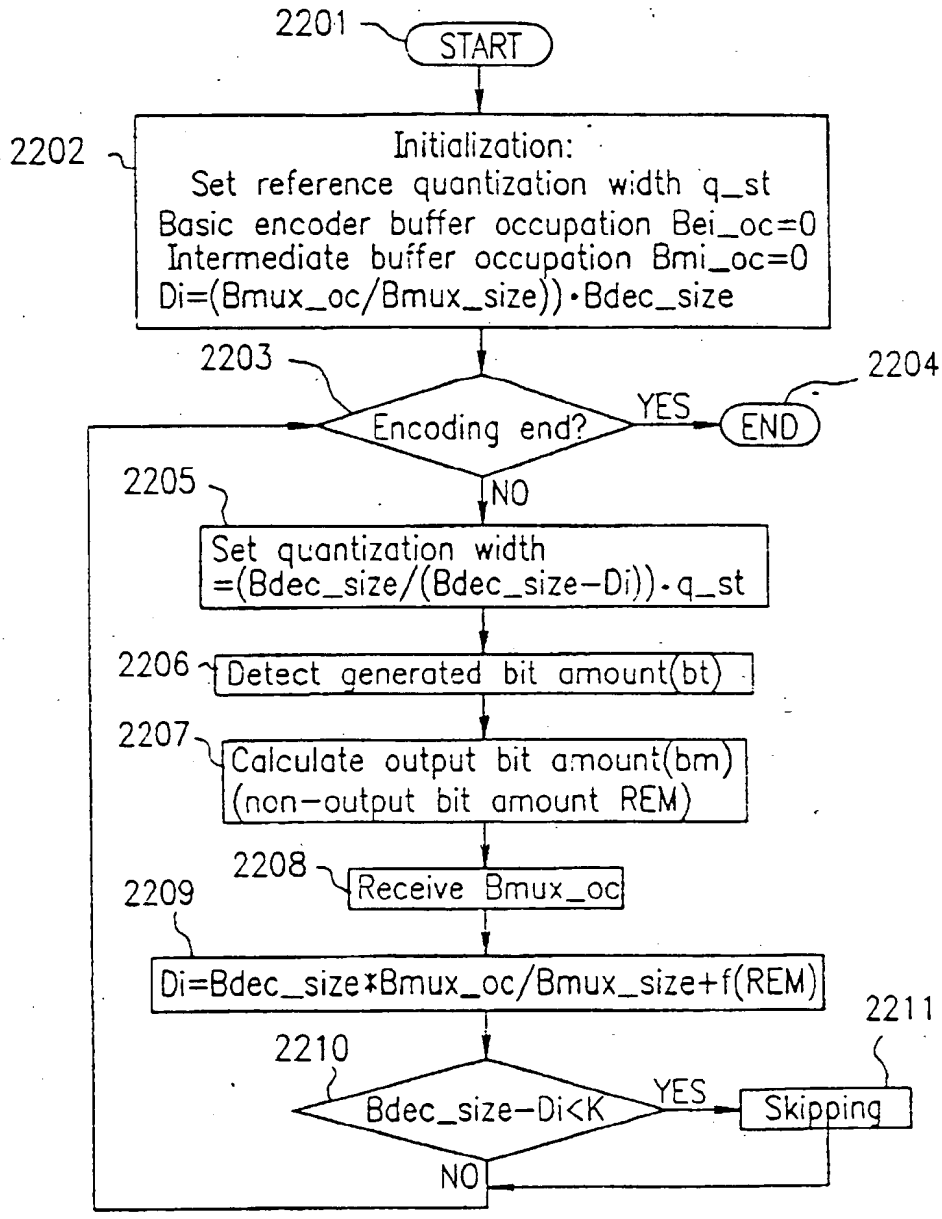
FIG. 27



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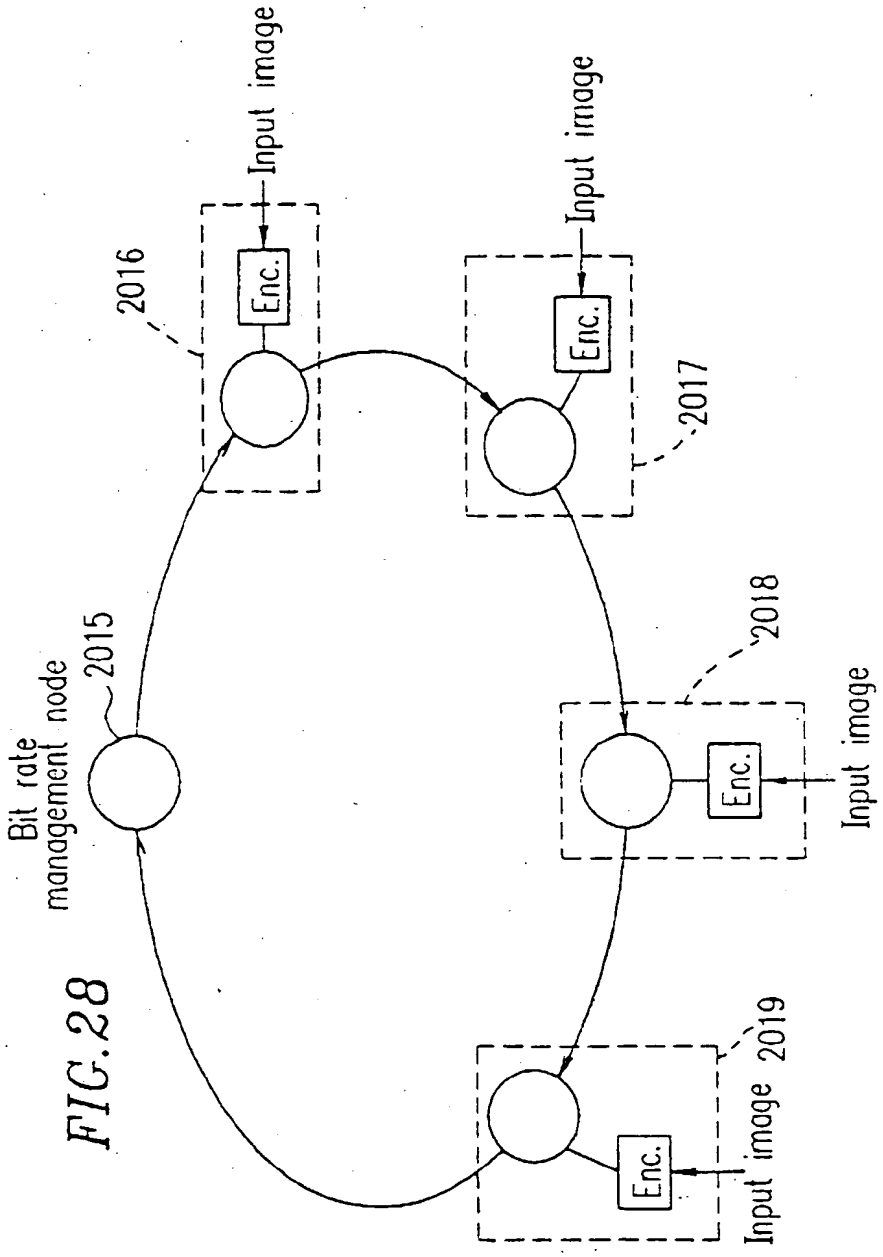

FIG.28

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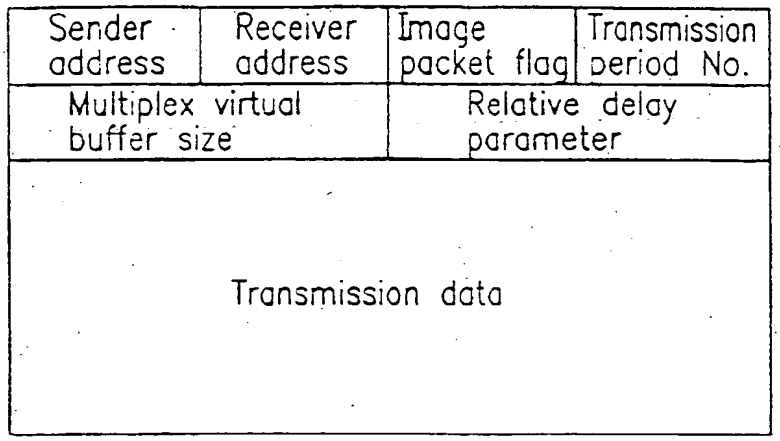
FIG. 29



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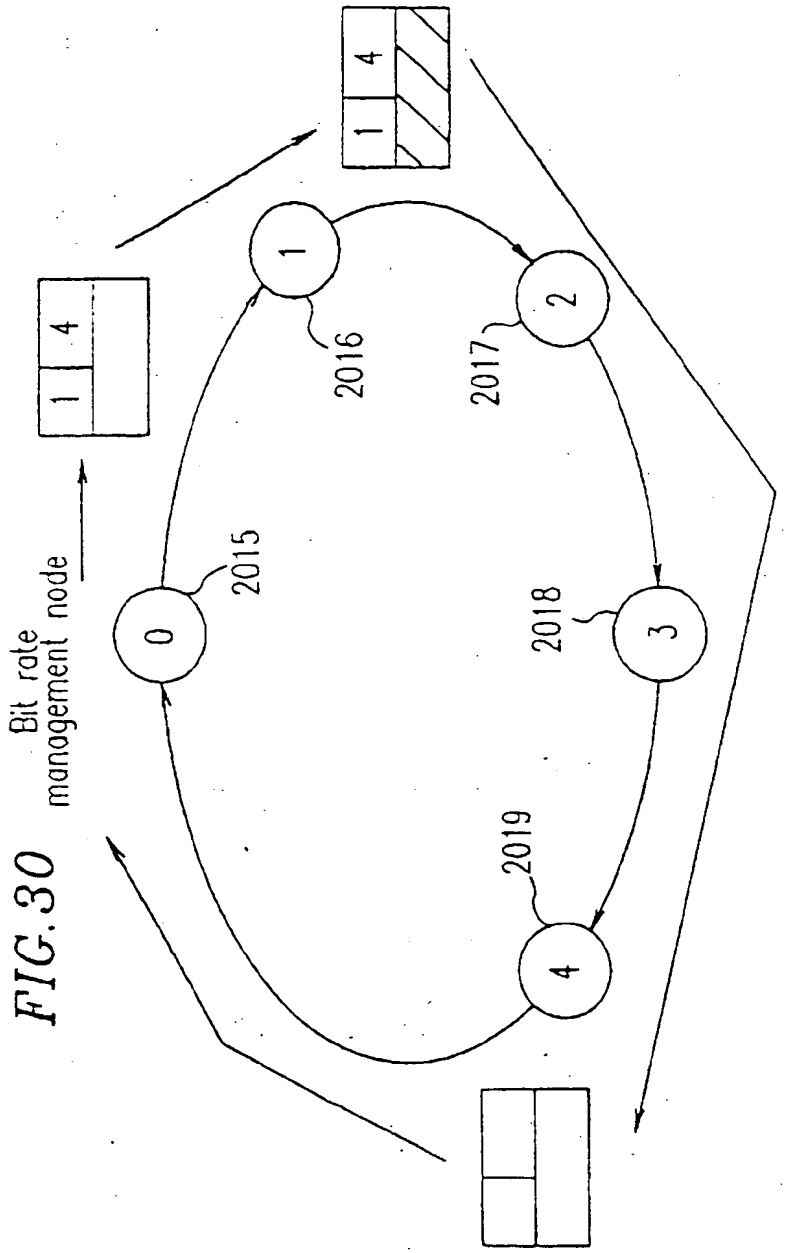

FIG. 30

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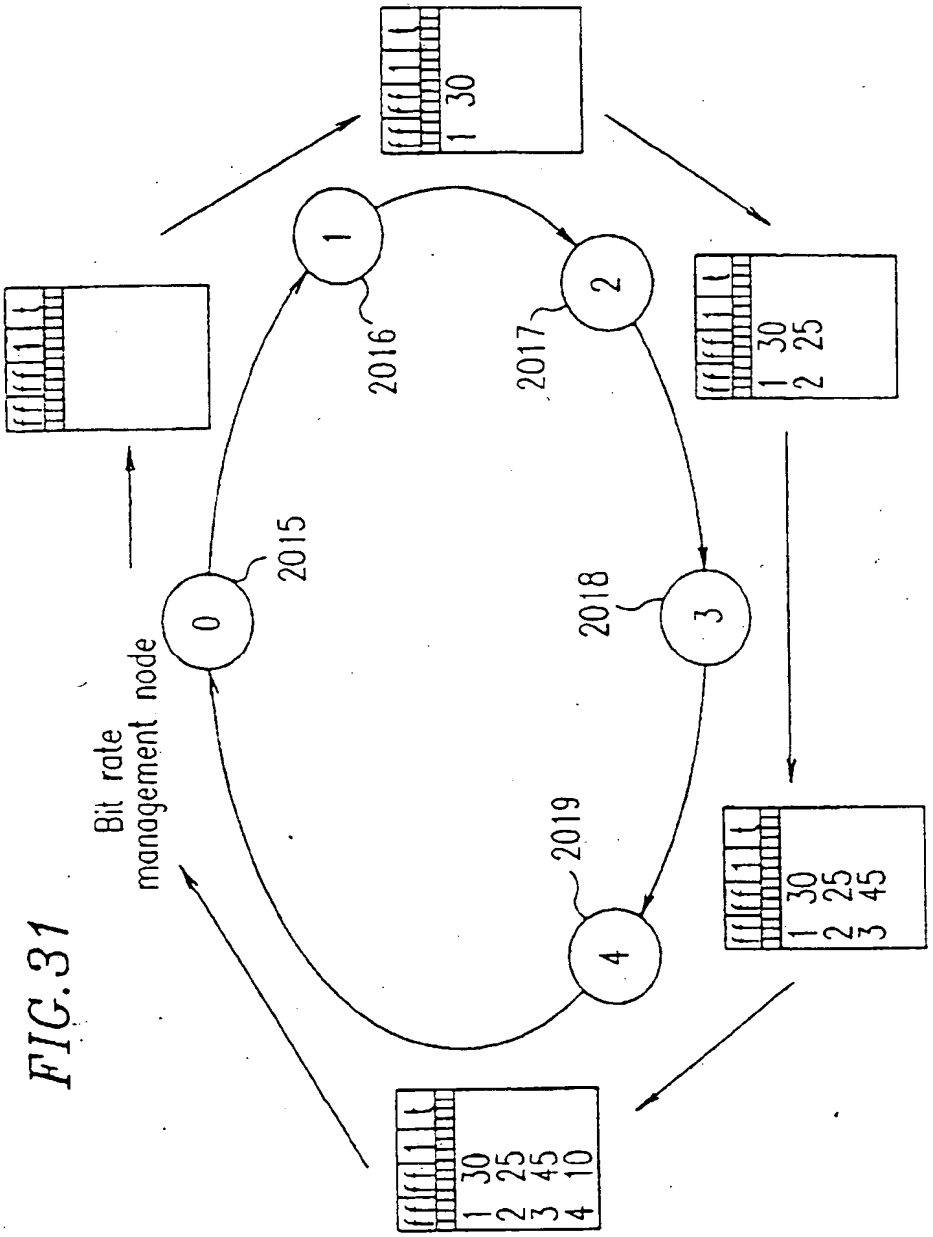

FIG.31

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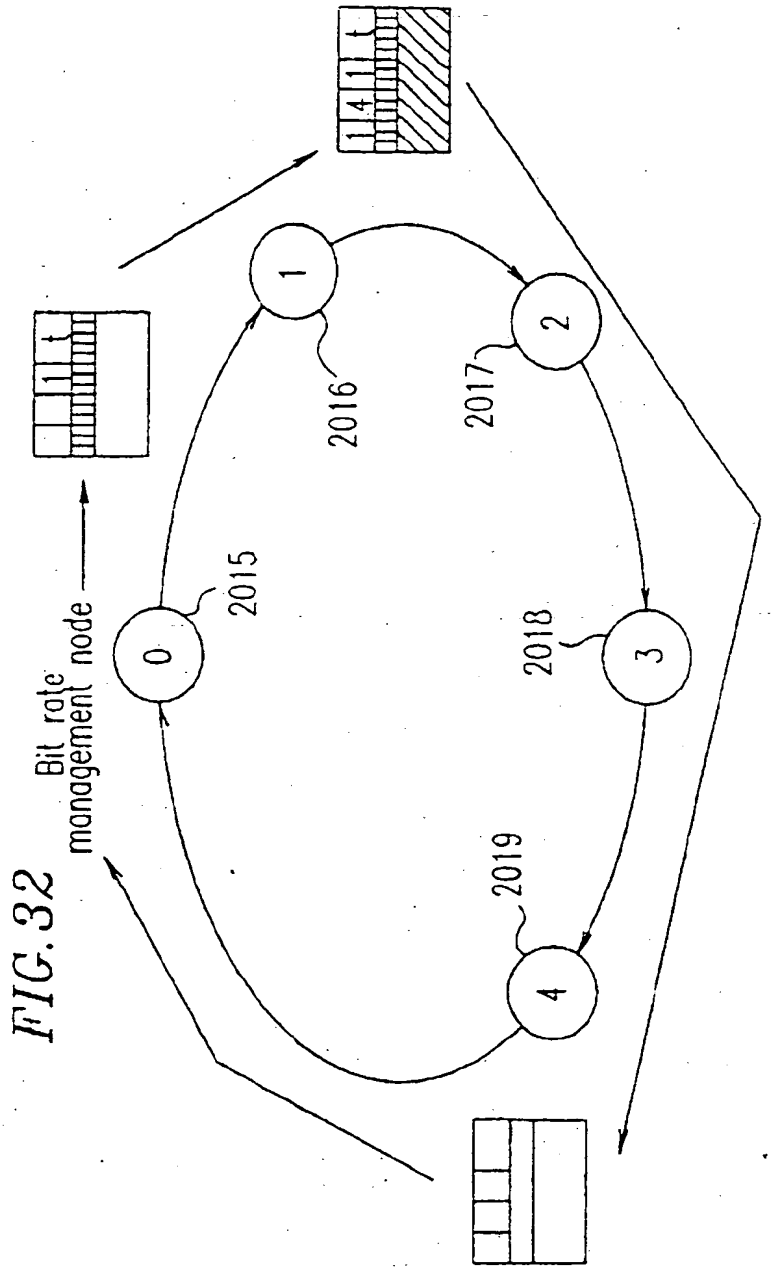

FIG. 32

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FIG.33

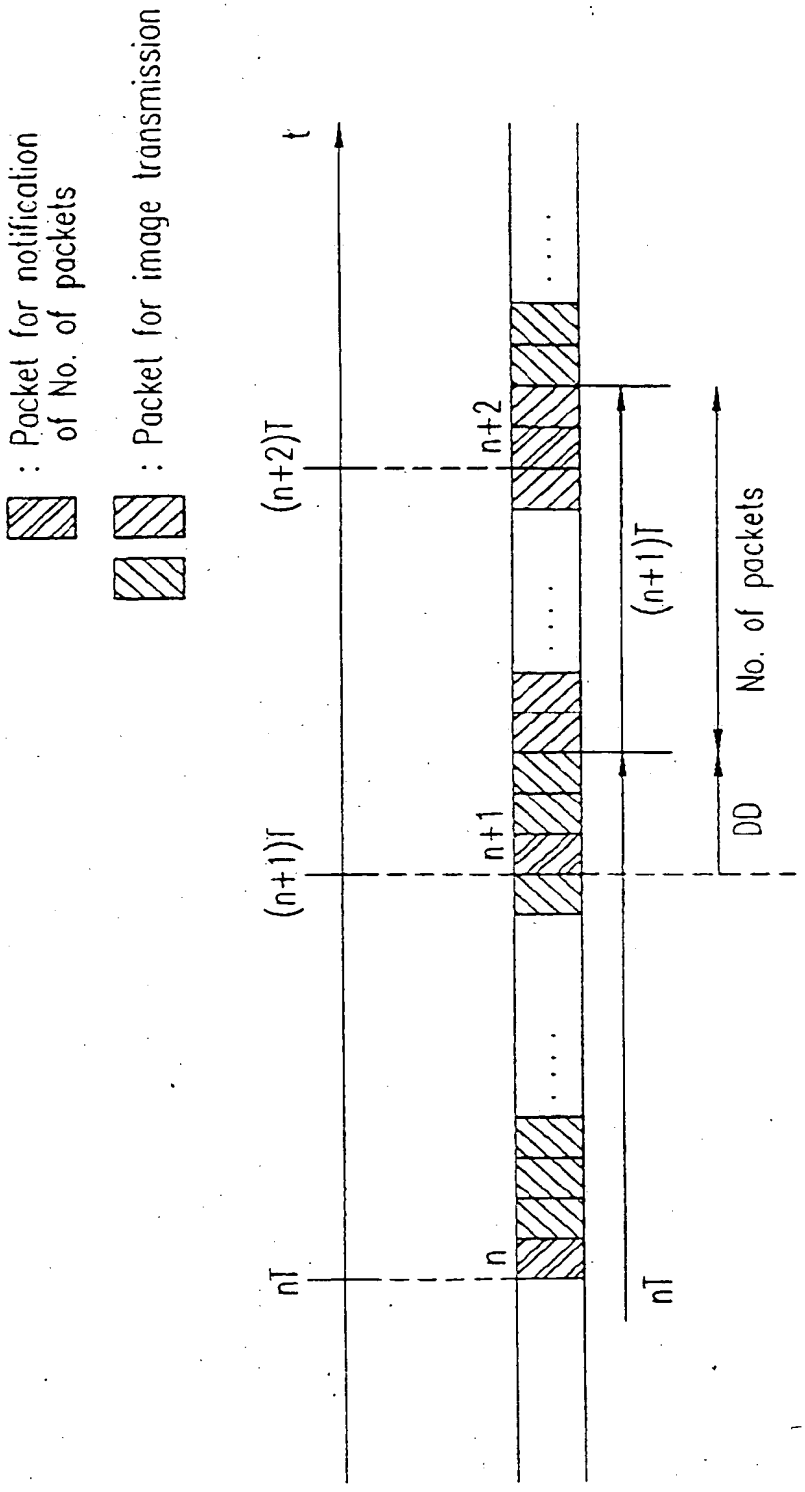

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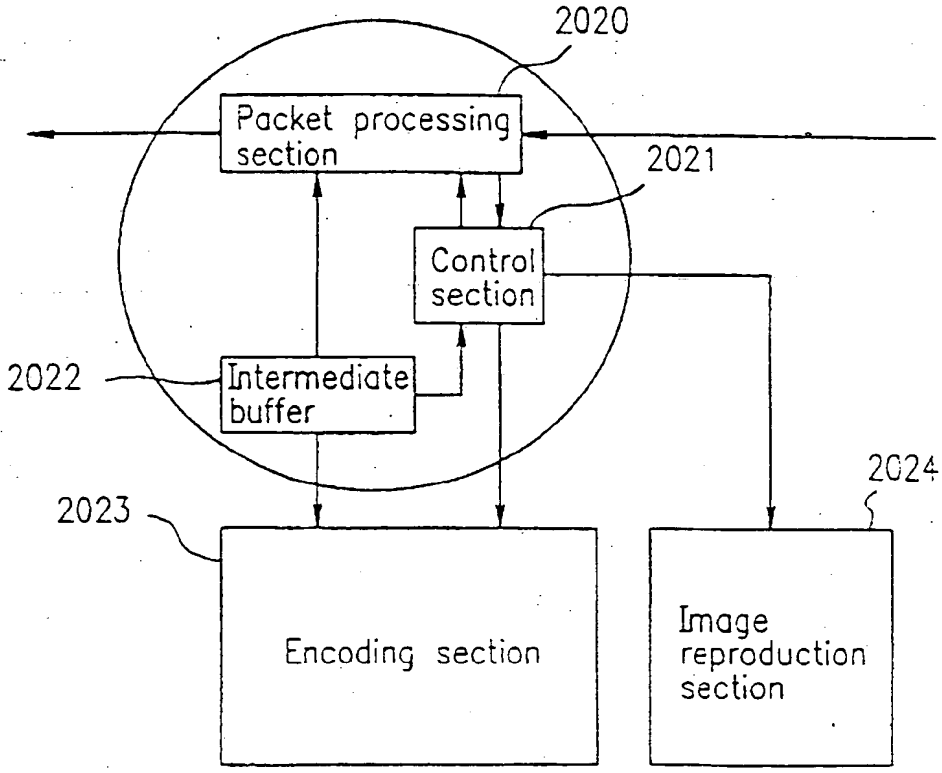
FIG. 34



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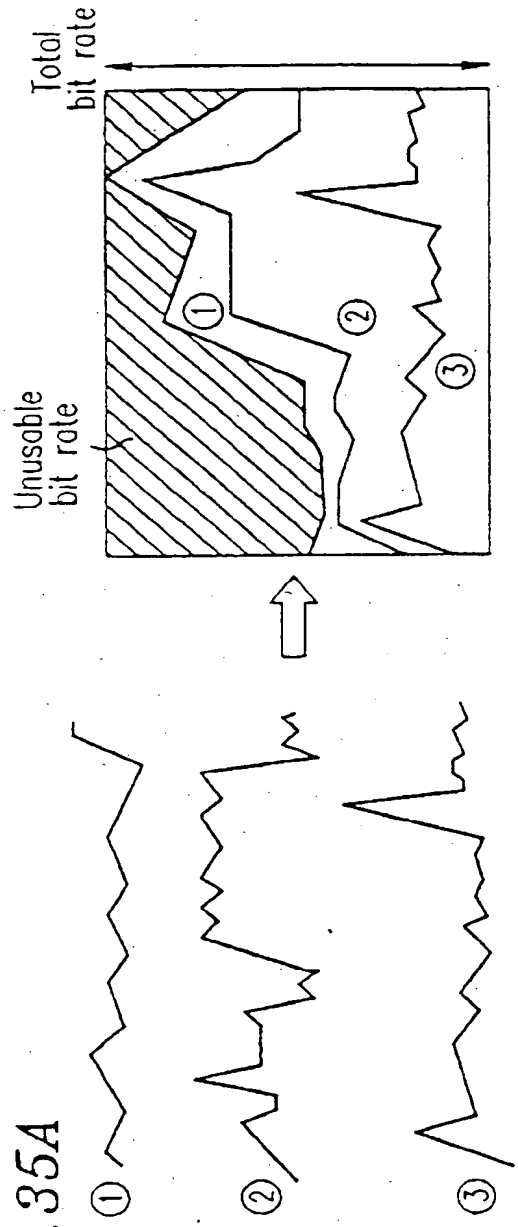

FIG. 35A

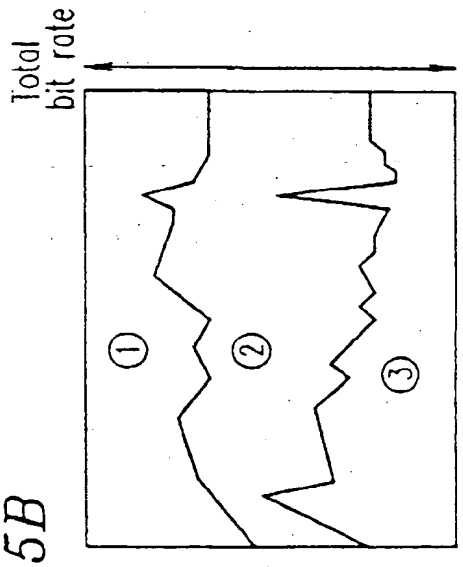

FIG. 35B

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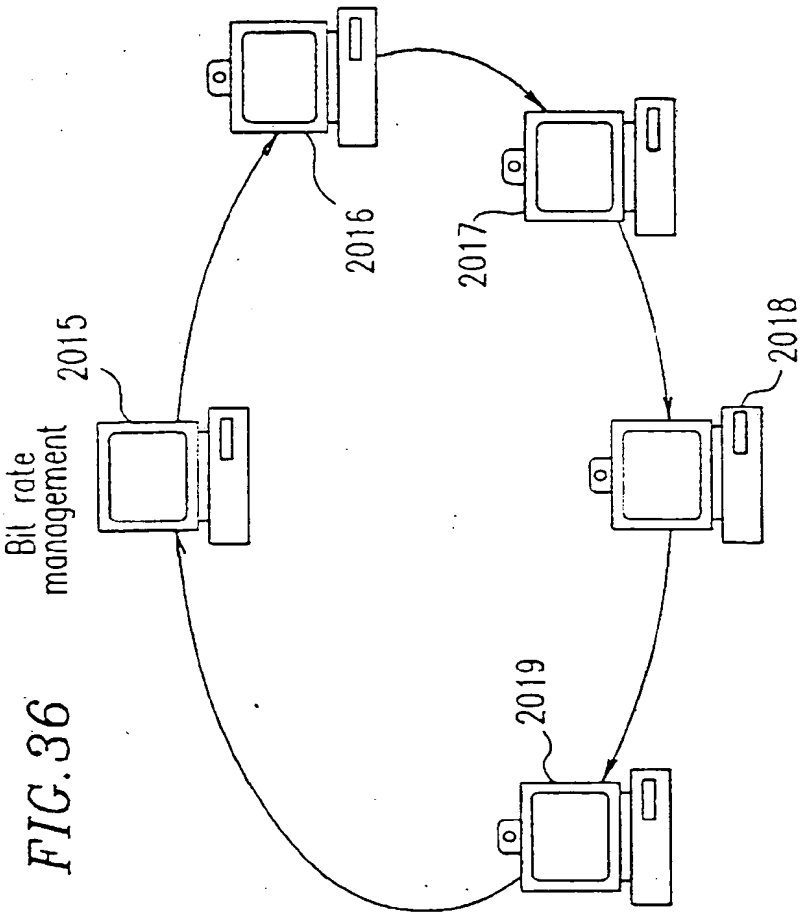

FIG. 36

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FIG. 37

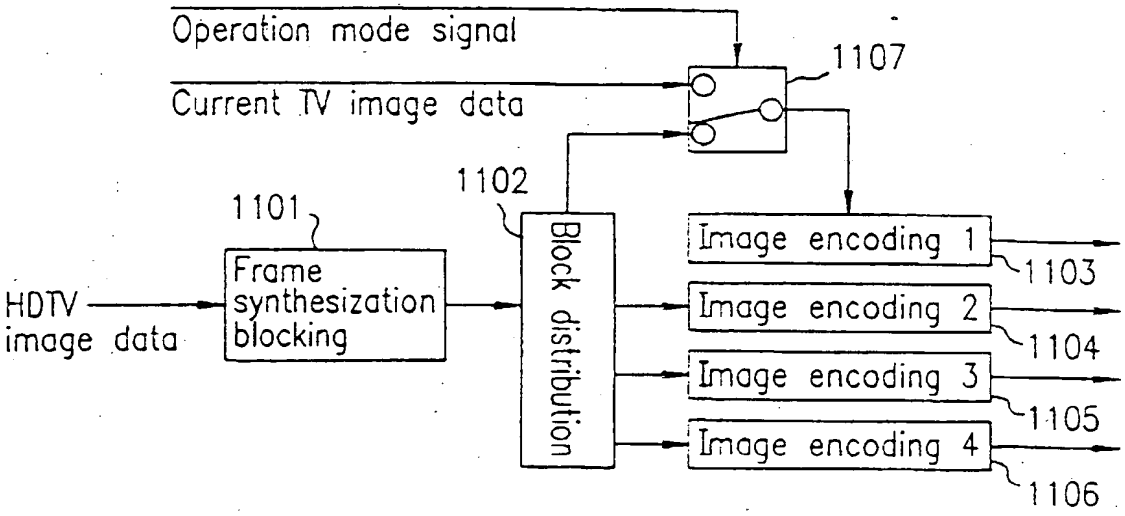

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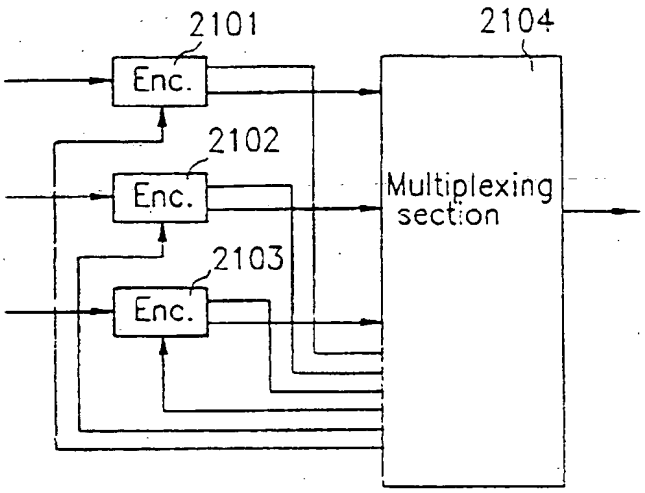
FIG. 38



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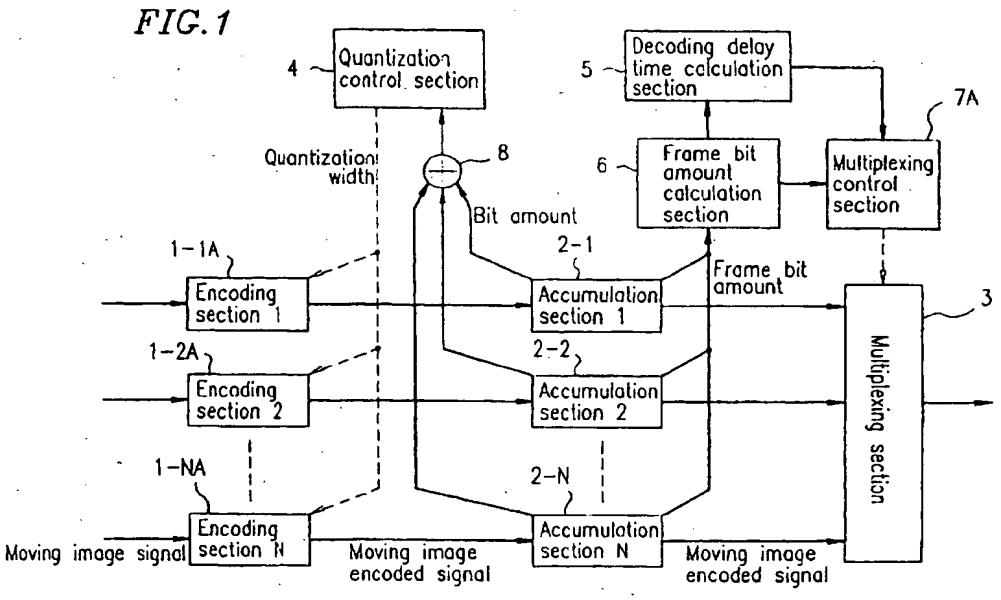
(54) Method and apparatus for encoding, multiplexing and transmitting a video signal

(57) The moving image encoding device for encoding a plurality of moving image signals of this invention includes: a plurality of encoding sections for encoding the plurality of moving image signals, the encoding sections being provided with a plurality of quantization sub-sections for quantizing the plurality of moving image signals with predetermined quantization widths; and a quantization control section for controlling the quantization widths used by the quantization sections simultaneously.

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 97 11 9430

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 550 843 A (GENERAL INSTRUMENT CORPORATION) 14 July 1993 (1993-07-14) * column 4, line 40 - column 5, line 12 * * column 7, line 44 - column 8, line 6 * * column 9, line 18 - column 10, line 3 * * column 10, line 57 - column 11, line 23 * *	1,3,10	H04N7/58 H04N7/24 H04N7/26
A		2,4,9, 17-26	

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~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	20 June 2005	Fassnacht, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EUROPEAN SEARCH REPORT

Application Number
EP 97 11 9430

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	HSUEH-MING HANG ET AL: "DIGITAL HDTV COMPRESSION USING PARALLEL MOTION-COMPENSATED TRANSFORM CODERS" IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE INC. NEW YORK, US, vol. 1, no. 2, 1 June 1991 (1991-06-01), pages 210-221, XP000214523 ISSN: 1051-8215 * section III. * * figures 1,2 *	1,4	
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A	WO 95/29550 A (THOMSON CONSUMER ELECTRONICS, INC; OZKAN, MEHMET, KEMAL; BEYERS, BILLY) 2 November 1995 (1995-11-02) * abstract * * page 3, line 20 - page 3, line 35 * * claim 9 *	10	TECHNICAL FIELDS SEARCHED (Int.Cl.6)

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	20 June 2005	Fassnacht, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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O : non-written disclosure
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L : document cited for other reasons

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Application Number
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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-4,9,10,17-26

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European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 97 11 9430

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-4,9,10,17-26

   Moving image encoding device, with plural encoding sections and control of quantisation width

1.1. claims: 1-4,9

   Moving image encoding device, with plural encoding sections and quantisation subsections, with means for control of quantisation widths used by the quantisation subsections, and means for screen subdivision section disposed upstream of the encoding sections.

1.2. claims: 10,17-26

   Moving image encoding using a quantization width obtained based on a difference between a sum of bit amounts generated by encoding and output bit amounts of the plurality of moving image signals output after being temporarily accumulated, using a calculation of the empty capacity of each decoding buffer after a lapse of a predetermined period of no buffer-input, with distribution of a bit amount to effect stuffing based on a buffer differential value.

   ---

2. claims: 5-8,11-16,33-39

   Moving image multiplexing using a decoding delay calculation.

   ---

3. claims: 27-32

   Moving image encoding and multiplexing using switching of a destination of a plurality of input moving images, and with control of a switching state, of an encoding mode, and of a multiplexing mode.

   ---

4. claims: 40-45

   Image encoding with sending of information regarding a transmission delay from one encoding section to another, and quantisation width setting based on this information.

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

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20-06-2005

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